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ABSTRACT

Proceedings of the conference, "The Use of Animals in High School Biology Classes and Science Fairs," held in September of 1979 are presented. Sixteen articles reflect the views of educators, psychologists, and veterinarians on various perspectives of the controversial topic of using animals in elementary and secondary school science classrooms. (Author/CS)

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ANIMALS IN EDUCATION

USE OF ANIMALS IN HIGH SCHOOL BIOLOGY CLASSES AND SCIENCE FAIRS

Edited by
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The power of science without the control of compassion and admiration for life is too immense to be applied merely for the satisfaction of scientific curiosity. If Biology were taught in a manner that developed a sense of wonder and of reverence for life, and if students felt inwardly enriched from their study of life, these students would formulate as a life-long goal the steadfast determination to protect and preserve all life and would bring healing to a world desperately in need of it.

George K. Russell
American Biology Teacher, 1972

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FOREWORD

The use of live animals in education is a scientific enterprise which entails more than simply selecting the most appropriate animals for study. The treatment of the animals, particularly vertebrates, in the course of the study is a basic ethical issue even when the animal study is designed to provide students with an understanding of anatomical and physiological principles. Without such ethical concern, biology courses and science fair activities could continue to promote the attitude that animals are organic machines, to be manipulated to elicit a response, or to demonstrate a known phenomenon. Unfortunately, an understanding of complex biological principles is not easily gained and may be all too readily forgotten or distorted when the student has no real appreciation for the animal as something other than an "organism" or "model" for study purposes. All animals are unique living beings with a behavioral repertoire and needs (indeed, interests) specific to that individual, which are characteristic of its species and adapted to its natural environment. The student who is not challenged with such knowledge is not being fully educated.

Our objective in publishing these proceedings is to promote the idea that biological studies involving animals are a necessary and integral phase of understanding living processes but that any such studies should at the same time foster a humane regard for the animal kingdom. Learning experiences that entail animal suffering or stress cannot be justified, as they are not necessary to add to a student's character or educational development.

The papers published here were presented at a two-day conference, sponsored by the Institute for the Study of Animal Problems in connection with the Myrin Institute for Adult Education, to investigate the ethical and practical issues underlying the development of a sound program for the study of living organisms in secondary education. The papers are controversial and are to some degree subjective and provocative. The questions put forth by the authors have not all been answered, nor are they likely to be in the near future as our immediate attitudes and beliefs toward animals continue to change with the evolving philosophies and sensitivities of different societies. However, the papers provide a broad base for those interested in the ethical considerations relating to live animal experimentation in educational programs, and it is anticipated that the proceedings will stimulate further study and debate.

*Heather McGiffin
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The sponsors of the Conference thank and congratulate the authors of this publication for addressing a controversial subject with candor and what can best be described as scholarly sensitivity. We are especially indebted to those individuals whose decision to participate in the conference was made with the knowledge that their stand would not necessarily be a popular one. Their presentations and discussions made the conference all the more informative and instructive.

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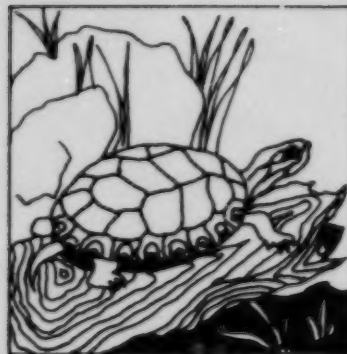
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SESSION I

Educational Objectives and Experimental Review

CHAIRMAN: MICHAEL W. FOX



Objectives of Animal Use in Biology Courses

William V. Mayer

Abstract

To confine discussion of educational use of animals to experimentation is to focus on only part of the animal use problem. To focus on use of animals in the classroom solely is to negate the value of field and community resource areas such as zoos, animal parks, nature trails, etc. The primary objective in dealing with living organisms is to inculcate a respect for all life. Objectives that focus on use of living animals for experimental purposes can, at best, be secondary and may in many cases be contrived. An understanding of animal life requirements and animal contributions is an objective worthy of pursuit. Living animals in the classroom give viability to biological studies and provide opportunities for animal-human interaction that can be channeled into a series of positive behaviors. Animals have been misused in classrooms by being considered solely as experimental objects through which to ascertain the fundamentals of anatomy and physiology. Much broader objectives must be sought if animal use is to make a meaningful contribution to the educated citizenry of the future.

Introduction

Biology is the study of life and, as such, should deal with the living. Classical biology was chiefly an investigation into systematics and morphology, based primarily on preserved, stuffed, skeletonized, or otherwise prepared specimens. Laboratory investigations focused not on biology, but rather necrology (Mayer, 1973). In many biology classes the student never saw a living organism. The emphasis was not on experimentation; it was confined to observations of a confirmational nature. The laboratory, as it was called, was primarily a site for dissection. This was conducted on the basis of look-dissect-draw-label-memorize. There was little for a student to gain from such exercises that was not already obtainable in the labelled diagrams included in most textbooks. Limited experimentation, here again basically of a confirmational nature, was conducted through the discipline of physiology. Nerve-muscle preparations and observations of heartbeat, peristalsis, and occasionally metabolic rate were about the only ways live animals were used in physiology courses.

As we approach the end of the twentieth century, declining enrollments, static budgets, high costs, additional workload, limited facilities, and the expenditure of time militate against laboratory work in biology. One finds not more but less emphasis on

the laboratory today than in the early sixties. Of the laboratory work offered, only a fractional amount is devoted to animals, and of this, an even tinier fraction involves live animals. The frog, by choice or custom, is still the most commonly used laboratory vertebrate. The care and attention that must be devoted to live vertebrates in the classroom has worked strongly against their use. Thus, animal use in biology classrooms is, at best, limited; and the publicity concerning inhumane treatment of animals in biology classes is primarily concerned with that aberrant incident such as in a science fair where teacher and student are involved in an experiment usually beyond the capacities of both.

There is no call, from an educational standpoint, to subject animals to any form of cruelty. The frustrated medical school aspirations of some teachers and frequent parental hopes that Little Johnny may become an MD do not provide a rational basis for surgical intervention sloppily performed and imperfectly understood. It is not the province of the secondary school to teach either cruelty or callousness, and to subject animals to either for the pursuit of trivial and in some cases deceptive objectives cannot be condoned.

If animals, and particularly vertebrate animals, are so little used in the formal course work of biology, one would doubt the necessity for a conference on the use of animals in high school biology classes. However, it is the presence of living organisms that distinguishes biology classrooms from the others in an average school. Therefore I, for one, speak for increased use of animals in high school biology classes and science projects. Not in the pseudo-surgical style of pretended experimentation, but with an entirely different set of objectives. In looking back through high school laboratory manuals, it is hard to see as valid an objective such as, "To dissect a frog and study its internal structure." Remembering that for at least 50 percent of our population, biology may be the first, last, and only science to which they are exposed, it is difficult to ascertain the value of knowing the internal structure of a frog and how to dissect one as a long-term educational goal for the average citizen. That is about as meaningful as having the students learn the parts of a crayfish appendage, which can also be considered inert knowledge, for those names have no meaning in the life of most citizens.

The question constantly has to be asked, *why?* Why are we doing certain things in the classroom? And if the answer to why is trivial or limited to but a tiny fraction of our population, it seems an unnecessary task to pursue at this level. The answers to *why* questions constitute a set of objectives for animal use in biology courses.

The Purposes of Education

Educational objectives are somewhat like the weather; everyone talks about them, but little is done about them. When one questions objectives, one normally gets high-sounding platitudes in response. The purposes of education are to teach students to think, to become productive citizens, to be able to learn on their own, and to become reasoning and reasonable beings. To be against these proud objectives is akin to being against both mother and apple pie. But just because these are so broad and difficult to measure, objectives almost trivial in nature are frequently substituted. Classrooms then concentrate on detail rather than concept, and on measurable outcomes in lieu of pervasive objectives more difficult to quantify.

Education is a multibillion dollar, ad hoc enterprise which, because it has ill-defined objectives, is pulled and hauled from one side to another by pressure groups and educational faddists. Many of the pressures are not in themselves bad. The

concept of back to basics would be acceptable if we could only agree on just what it is basics were, and whose basics we should go back to. Educationists are constantly under pressure to add something to the curriculum, remove something from the curriculum, or change something within the curriculum. And, in attempting to placate those diverse and often contradictory points of view, education seems to proceed in a pattern consisting of two steps forward, one step back, followed by a series of lateral arabesques.

As noted, in order to establish a meaningful educational pattern, the question **why?** must be constantly asked. Why are we doing certain things? Why is a certain topic in a curriculum? Why are we having students do this, that, or the other? And answers such as "We've always done it," "It's good for the student," "It prepares them for college," "It trains the mind" are inadequate substantiation. We might start with asking why biology is taught at all in high school. If its purpose is to acquaint the student with the living world and his interrelationships with it in time and space, then all other objectives become subsidiary to that one. We realize that our primary objective is not the training of biologists, for it is not the role of the secondary school to initiate career goals that would of necessity be based on inadequate exposure to a given field. Fifty percent of today's citizens do not go on to college, and secondary school for half our population must be regarded as a terminal educational experience, not a college preparatory one. Of thirty students in a required ninth-grade science course, only one can be expected to study science as far as the bachelor's degree level. Of a thousand students entering the fifth grade, only 732 will graduate from high school, only 285 will enter college, only 220 will graduate, and only 40 of those will obtain science degrees (Tarp, 1978). In our secondary schools, therefore, we are training citizens for scientific or, in this case, biological literacy. The content of the curriculum must be judged within that objective.

Changing Roles of Animals in Education

The past two decades have seen marked changes in the content and conceptual load of secondary school biology courses. I am proud of what the Biological Sciences Curriculum Study has done to bring about these changes, for I believe them to be changes for the better. Prior to 1960 the emphasis in high school biology was primarily on morphology and systematics. Organism structure and organism identification were the two major emphases in terms of course content. The past twenty years have seen a diminution in this emphasis to accommodate the inclusion of such topics as molecular biology, genetics, ecology, behavior, and similar topics. With this change in content and concept, together with the changing role of the school, there has actually been a diminution rather than an increase in animal use.

The biological supply houses that used to provide barrels of pickled frogs, crayfish, grasshoppers, earthworms, and other organisms for dissection find this portion of their business greatly reduced. Economics, if nothing else, has dictated less use of expensive, expendable laboratory supplies such as preserved or living specimens. The changing school day, the unionization of teachers, and the general turning away from science have also brought less dependence on laboratory-centered activity and more on textbook exercises. Many of the affective objectives of education can be inculcated without extensive laboratory experiences, as evidenced by "Invitations to Inquiry," developed by Joseph J. Schwab (Mayer, 1978). In the face of such changes, what is the role of animals in a biology classroom?

The Value of Animals in Education

Why are animals to be used in biology courses? One answer is to give the students an acquaintance with examples of the vast panoply of organisms that exist. Representatives of various animal phyla provide dramatic evidence of diversity, adaptation, and behavior. To see the underside of a starfish as it crawls along the glass of an aquarium will leave a much more vivid picture of the structure and function of a water vascular system and tube feet in locomotion than any number of pictures or lines of text could possibly communicate. To feel that a snake is not cold and slimy but at room temperature and surprisingly dry is to communicate an important bit of information about this legless reptile. To touch a toad and not get warts is to give lie to the old wives' tale. The examples are infinite. Aquatic and terrestrial, vertebrate and invertebrate, male and female—all attest to the infinite variety within the animal kingdom, and each example teaches both conscious and subconscious lessons in a fashion far more vivid and far longer retained than simply telling or reading or looking at pictures. Demonstration, then, is an effective form of education, and to observe and perhaps touch a variety of living organisms constitutes a powerful lesson in what an animal is and what a great diversity of animals there are.

A second answer to the question *why?* is to provide an understanding of animal behavior, which can only be communicated by living organisms and observation of their living. Watching a rabbit or a guinea pig eat a meal or clean its young provides data not easily communicated either by photograph or text. Listening to a bird sing, a frog croak, or a snake hiss provides dramatic evidence of another type of communication. To watch interactions between organisms—the behavior of a single mouse is not the same as it is when that mouse is with others—is to begin to understand social structures. Social interaction teaches powerful lessons.

A third answer to why I would keep animals in the laboratory is to develop an understanding of animal care and a sense of responsibility for caring. The nutritional requirements of animals—the food, the water, the necessity for cage cleaning (a concept of sanitation), the development of an animal environment, suitable protection against temperature changes (wind, sun, noise), nesting materials or bedding, balancing an aquarium, the interaction of plants and animals—all can be taught by the care and maintenance of animals. An aquarium, a terrarium, or animals individually or collectively housed teach a variety of lessons that require both thought and responsibility. To have responsible students take animals home for weekends or holidays enlarges upon this objective. Living organisms meet certain childhood needs not likely to be as effectively met by other alternatives (Wastnedge, 1972).

Caring for animals, observing them, understanding their requirements for life, comprehending their diversity, and learning new things about them are worthwhile objectives. But transcending all of these is a more important and derivative objective—respect for living things. Respect is not taught directly: it is learned by example and application. I cannot think of a more powerful objective for animal use, and one unlikely to be achieved in any way but by contact with living organisms within a framework of guidance and example.

These objectives, which are primarily within the affective domain, are difficult to clarify and to measure. But to make no attempt to achieve them is a capitulation to the more prosaic and mundane type of objective as when the student places acetic acid on the back of a frog to observe a reflex action far better demonstrated through the patellar reflex of a fellow student.



I inveigh against the use of animals in contrived and essentially specious circumstances. The bulk of so-called animal experimentation at the secondary school level constitutes not only not an experiment but frequently a device to teach lessons we really do not want students to learn. Sacrificing animals for trivial causes cannot be justified. So many times teachers have said that students must use animals in order to absorb the scientific method or to understand experimentation. But the scientific method and controlled experiments can be performed without the use of any animal or indeed, of any living organism. As a matter of fact, living organisms are largely unsatisfactory experimental subjects because of their high degree of variability and the extreme difficulty of controlling those variables in order to have a truly controlled experimental situation. Teachers frequently complain that students have little success with animal experimentation because the answers "don't come out right." Animals constitute fairly complex experimental organisms and require a degree of sophistication for their proper use not possessed by secondary school students nor, occasionally, by their teachers.

Animals in Science Projects

As noted in the title of this conference, we are to deal not only with high school biology classes, but also with science projects. It is in this latter category that most of what has been categorized as animal mistreatment occurs. Too often, students have inadequate supervision for science projects. They are designed, in large measure, to be done on the student's own, as independent pieces of work. Frequently, they are accomplished outside the school. But the greatest source of difficulty is attempting to run before one can crawl. Students are naturally attracted to frontier kinds of research, usually the more bizarre the better, and they attempt sophisticated experimentation with crude apparatus, little comprehension of what is to be done or how to do it, in a largely unsupervised milieu. This experimental use of animals has often been occasioned by the frustrated medical ambitions of certain biology teachers rather than by the applicability of the experimentation to the curriculum as a whole and the student enterprise in particular. There are teachers who feel that animal experimentation is a worthy secondary school activity because of what one might call the Dr. Kildare Syndrome. Unfortunately, most of this animal experimentation is not only beyond the skill of the student but frequently beyond the skill of the teacher. It ends up teaching no lesson except that animals suffer and die in inexperienced hands.

I have judged science fairs at local, state, and national levels, and in talking to the students have found many but poorly understood what they had attempted to do when using animals. Some did not demonstrate responsibility for the living organisms in their charge. Such activities not only do not constitute an educational experience, but demonstrate an absence of educational growth and a callous disregard for living organisms. It redounds poorly on both the teacher and the student to attempt work for which neither has sufficient background. Rules by which people would be quite willing to abide in the physical sciences seem to be ignored in the biological sciences. One does not usually begin constructing one's first refracting telescope by grinding a twelve-inch mirror; one starts out on smaller blanks to master the technique. In electronics, students are perfectly willing to master basic circuitry before working with microcircuits, but I have yet to see a student who understood enough about the normal behavior of an organism to be able to contrast it with whatever the experimental behavior turned out to be.

There are many worthwhile lessons to be learned from living organisms that could constitute decent science fair projects that involve no harm to the organisms involved. Studies on locomotion, behavior, interaction, care of the young, food preferences, and so on can all be conducted without any trauma to the organisms concerned and certainly would teach more than an ill-conceived application of little-understood technology to less understood animal systems.

Human-Animal Interactions

It is not going to be possible to isolate students from animals. At home they may have dogs or cats, or be given a baby chick or duck at Easter, or have an aquarium, or pull wings off of flies. By having as a major objective of animal use respect for living things, the latter will be unlikely to happen. Not only are students exposed to animals in the neighborhoods where they live, but zoological parks, wild animal parks, aquariums, and seaquariums are all sources of information about living organisms that transcend the classroom and can be profitable experiences to students trained in observation and understanding of living animals. Visits to national parks also provide opportunities to observe and understand.

The problem is not simply confined to animals in classrooms, but animals in relation to human beings everywhere. Field and community resource areas are rich in examples of human-animal interaction. We've all seen people feeding animals that should not be fed, attempting to pick up animals that bite, poking at, yelling at, running after, and in general endangering themselves, the animals, and those people who will come later to observe frightened and antagonistic organisms. Objectives of animal use should transcend the boundaries of the school. But only by beginning in the classroom can we teach those lessons that have applicability beyond the boundaries of the school.

Conclusion

I do not believe in random animal experimentation in secondary schools. I do believe in using animals to inculcate the kind of affective objectives that will stand the students in good stead, not only in the classroom, but what is more important, outside the classroom as well. Only then will they come to develop that respect for all living things we must have if our current environment is to remain unscathed for future generations to possess and enjoy.

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Student (and Animal) Welfare

Leonard M. Krause

Abstract

Adolescents exhibit affection for numerous vertebrates and appear to sympathize and to identify with traumas these animals experience. Therapeutic benefits students attach to nurturing and breeding certain vertebrates are evident; destruction of these same creatures produces clearly negative attitudes by students toward the science course and the instructor. "Case histories" documented while teaching high school students working with vertebrates are reviewed and are related to specific techniques (e.g., pithing) utilized by numerous instructors. Motivation, increased attention span, sustained interest, involvement with community issues and other desirable educational goals are demonstrated to be resultants of student involvement with living vertebrates studied in their "natural" state.

Introduction

The "charge" to speakers during this first segment of the conference is "... to examine the basic premise of education—and the extent to which animal studies may contribute." There are, in fact numerous premises, and reference will be made later to them under the rubric, "Educational Objectives." In order to make concrete the objectives, reference will be made also to specific in- and out-of-class hands-on activities with vertebrate animals. Consequently, my presentation will overlap somewhat with the objectives set for the afternoon session, and I am assuming that this paper will, nonetheless, meet with the approval of the chairman, and that it will be acceptable to subsequent speakers.

The Institute for the Study of Animal Problems (ISAP) clearly exists to relate to animal problems. My opening position suggests that numerous animal problems derive from people problems. Some kids in my neighborhood derived evident pleasure from dashing frogs against rocks in a nearby creek. Beetles were tortured with matches. These children were perhaps sublimating aggressions against creatures whose defenseless posture enabled these events to occur. A *Saturday Evening Post* cover by Norman Rockwell comes to mind. The cover was divided into four scenes: The first quarter showed a husband being reprimanded by the boss; the second scene depicted that husband expressing anger toward his wife after he arrived home. The third part of the scenario illustrated the wife yelling at her child and the last quarter of the cover enabled the viewer to see how the child vented his frustration on the pet dog. The child was vigorously wagging his finger in the face of the dog whose expression was priceless. No animal maltreatment was depicted by Rockwell, as we would expect. The scenario, however, has remained in my mind as one example of passing the buck to a defense-

less creature. And, one must wonder about the reasons children would have for dashing frogs to death against rocks.

Other problems of people include human, microbially-induced disease. Simply put, people become ill from reacting to various microorganisms. It is standard procedure to study reactions of animals to microorganisms associated with human disease to better understand the mechanisms of interaction. The problem becomes one of the animal which is the experimental entity. We accept utilizing the convenience of animal experimentation at the professional level, though not always, I must add. We find it objectionable that professional-level investigations have found their way into high school level texts. An example is found in texts which suggest the testing of Koch's Postulates. Koch asserted that finding and identifying the causative agent of that reaction we label a disease involved a four step procedure. Briefly, one exposes some animal (or plant) to a pathogen and awaits a reaction. The animal or plant then is sacrificed and an attempt is made to isolate and to culture the suspected causative agent. Lastly, the cultivated agent is enabled to enter another but similar experimental animal (or plant) species and the investigator observes the reaction to determine the degree of similarity with that reaction observed in the former animal (or plant). Putting aside, for a moment, the potential danger to the student investigator or team, we must first recognize that animals are considered to be a *sine qua non* in the pursuit of knowledge about disease at the professional level; then we must recognize how people problems become animal problems when, at a secondary-school level untold numbers of animals suffer because of the hand-me-down process educators have evolved which result in professional-level investigations being adopted by amateurs.

People need drugs of various types for various symptoms. Animals are invariably the test agents.

Technology and population expansion impact on the ecology, changing animal habitats and affecting myriads of niches established over the millennia.

Clearly, people problems result in problems for animals. There is a challenge for educators to enable students to grasp this concept and for these same educators to engineer biologic activities which will allow students to develop what Schweitzer called, "Reverence for life," while also acquiring knowledge about animals and about the organized techniques which help us to learn more about life processes. There are opportunities to "neutralize" the tendency to dash frogs to death. Our *modus operandi*, however, must be to nurture in students a respect for life, rather than to inculcate a potential callousness by virtue of biologic activities selected.

There are several incidents which have occurred to me and which might be instructive to those of you here as visitors and as guests. I title these incidents: "Personal References—The Negatives" and "Personal References—The Positive."

Personal References—The Negatives

In 1960, two years after initiating a Science Research Club in the Plymouth-Whitemarsh (Pennsylvania) School District, the local Exchange Club invited me to speak at a dinner meeting. Part of my summary of student research activities included a description of a 10th grader's blood study with an albino rabbit. Blood samples from peripheral circulation in the ear pinna were correlated with time in a long range study. After my talk, a gentleman who introduced himself as the Director of the local SPCA requested speaking with me alone. I became petrified with concern, of course. During the private exchange, he indicated a greater concern with the psychological welfare of

the 10th grader, than with the potential for damage to the animal. He summarized several instances when students were beset with guilt when the animals assigned to them died during projects. At the time, I was a fifth-year teacher and found our friendly dialogue instructive. It gave me a new perspective.

At some time prior to this experience, I demonstrated pithing a frog (following Blue Version BSCS instructions) to my student lab assistant. He fainted. The lesson of this event did not make its impress until the subsequent discussion with the SPCA Director.

At a private school in the suburban Philadelphia area where I served as Director of Science for eight years, we studied living Protista in depth. Following the first observation lab, I began to clean a slide by washing the mixed culture down the drain. Several students who saw this literally screamed, "What are you doing—you're killing them!"

Interestingly, in a later interview conducted by a reporter from the *New York Times*, this student exclamation was given visibility in the text of the article. The reporter's assignment was to present diverse views of teachers and of students relative to work with living creatures in the schools. This experience became another of the several which have influenced my teaching strategies.

The climax experience, however, involved an episode which occurred in a biology class in Israel where my daughter was an exchange student for one year. Her teacher brought to class a live fish which he then killed and dissected. She has been a vegetarian since and avoided zoology classes which included animal experimentation. She was graduated last year from Cornell with a major in botany and horticulture.

Personal References—The Positive

After twenty-one years in suburban secondary school level science education, I decided to intrude into inner city urban science education, again at the secondary level. Control in classes with students was accomplished through a series of animal behavior activities described later. The episode most memorable occurred after one of my biology students was suspended from school (for an offense in another class, of course). The Assistant Principal reported a comment made by the suspended student. "Okay, suspend me from school, but let me go to biology, my chicken needs me."

Team work is a teaching strategy designed to bring students together. Cooperation is the goal. Over a period of two years (September '76-June '78), I have formed teams of 3 to 5 students in ten sections of science classes. The total number of students involved was three hundred.

One alternative to team work is traditional "straight" teaching. That is, teacher at desk; each student at his/her desk, relating only to a text through pencil and paper activities. This latter approach is an acceptable option, but it lacks in its capacity to bring together often antagonistic ethnic groups. The Black and Hispanic high school students in my classes were enabled to relate through the medium of common concern for the vertebrates put, literally, into their hands.

Numerous minority children enrolled at inner city schools are exposed to animals: roaches, rats, and to street dogs. There is a competition for food among these animals and thousands of human residents in each of our cities. Children rarely see zoo animals. The antipathy they have toward creatures which remind them of those mentioned above would seem to be a form of conditioned reflex. Exposure to other, "friendly" forms (goldfish, frogs, birds, gerbils) reconditions their negative attitudes to-

ward lower creatures, in my experience. The students learn to trust the animals in their care and, subsequently, provide "tender loving care." Both the animals and their keepers can benefit.

Educational Objectives

The discussion above alludes to achieving general, desirable educational goals with students through the use of living creatures. What follows are a number of educational objectives which are more specific and which have been categorized.

To introduce the objectives, first let's define "education." The Latin root is, *ducere*: To draw out. We want students to be drawn out; to think; to attack problems with tentative solutions, at the least. Students are not vessels to be filled, by the teacher, with facts and predigested ideas (Baldwin, 1967).

An important educational objective is intrinsic in the title of John Dewey's (1916) text, "Democracy and Education." In this fine work, he asserts education's role to be that of accomplishing, among other things, two major tasks. One—to create social beings; two—to enable students to realize there is no finite aspect to learning. There is no "end." The "end" is the "means"—the means to more learning, more discovery. New ideas beg additional questions whose answers are to be sought through orderly processes and through life's experiences. The "reverence for life" ideal of Schweitzer, referred to earlier in this paper, is implicit in this work of Dewey. A respect and love for all creatures should be a minimal goal of public educational systems.

Another goal derived literally from the translation of the word education is to let the child out. Educational systems should provide both the atmosphere and the mechanics which will enable the curiosity of our young people to function for purposes of learning within the context of the discipline in question (Isaacs, 1974).

Developmental Psychology offers much to educators as guidelines for evolving curricula. Jean Piaget describes levels of development from the concrete to the hypothetico-deductive (Athey, 1970; Piaget, 1970). Dealing with theory before exposing children to fact would be counter-productive, according to his studies and to the follow-up investigations of his work. Animal studies, properly sequenced, would provide for a logical and predictable set of developmental outcomes for pupils.

Enabling both sides of the brain to function in educational settings finds strong support among researchers. We tend to cater mostly to only one side. We must devise activities which stimulate the mechanistic, logical processes and aesthetic potential of the entire brain. Science education is a "natural" to accomplish this goal, because of its stress—on science. There is equipment to be manipulated, materials to be observed, problems to be solved. The currently popular "hands-on" approach provides the medium to accomplish the goal of making active both the right and left sides of the brain. Animals provide instant "hands-on" activities.

Organization of knowledge and of the processes to obtain same is paramount in a technologic society. Students can, via animal studies learn to: observe; record; graph, if necessary; share data in written and/or oral form. Animals are great motivators, in my experience, to accomplish these goals of science education. Working and playing with animals lends fun to activities such as recording data, considered onerous by so many, including professionals.

Lastly, animal studies provide a means of making contact with the community. This contact could include projects to create or to support a local zoo. At the other extreme would be an activity to control city rat populations. Table 1 and Table 2 sum-

marize several activities which have been found to accomplish the educational objectives described above.

Table 1: Classroom Activities and Educational Objectives with the Use of Living Vertebrates

VERTEBRATES

Goldfish

1. Respiration Rate
 - a. vary temperature
 - b. vary light
 - c. with aspirin
 - d. with 1:10,000 EtOH
2. Conditioning with light
3. Curing a sick goldfish with "Ich"
4. Morphology—external

Frogs

1. Respiration rate at varied temperatures
 2. Leap Frog (and Leap Man)
 3. Feeding with *Drosophila*
 4. Studying the Niche
 5. Metamorphosis
 6. Morphology—external
-

Birds (4 week chicks)

1. Perception of height vs. age
2. Distinguishing circles and squares
3. Morphology—external

Mammals (gerbils, hamsters)

1. Running mazes
 2. Morphology—external
-

Table 2: Summary of Educational Objectives and Implementations Procedures With Vertebrates

Emotional: Students have an opportunity to nurture a creature of their choice through providing needs for life.

Social: Team efforts to nurture and to study vertebrates provide the context for group cooperation.

Intellectual: Gathering facts, elaborating processes, data-gathering, problem-solving presentation of a project are among the intellectual components associated with projects involving vertebrates.

Motivation: Certain vertebrates lend themselves to generating interest in biological activities among students who would otherwise be uninterested following a purely text-book approach.

Technical Skills:

1. Observing
 2. Recording data in tables or in qualitative form
 3. Investigating with a control
 4. Manipulating equipment
 5. Providing animal's needs
-

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Learning from Animals: Models for Studying Physiology and Disease

W. Jean Dodds

Abstract

Animals can serve as valuable educational tools for elementary and high school students. By teaching young people reverence for all forms of life at an early age, it is possible to instill in them a proper perspective concerning the welfare and humane stewardship of animals. Exemplary subjects include the various aspects of evolutionary and embryological development; normal physiological processes, the mechanisms and pathology of naturally occurring infectious, metabolic, genetic and neoplastic diseases and aging; and an appreciation of the inevitability of death. Such studies can serve as learning models for students because these processes parallel or closely resemble those of man. This approach teaches the ethics of animal usage and can be shown to result in benefits not only to humans but also to other animals. Although much has also been learned from research on experimentally-induced disease in animals, these techniques should be reserved for the appropriately supervised research laboratory and should not be practiced in the high school classroom.

Introduction

As a scientist with a deep-rooted love and compassion for living creatures, I am convinced, from my own experience, that research with animals can be humane as well as informative, and that such studies benefit not only mankind but also other animals. The answer to the current concern for humane care of animals, alleviation of pain and suffering, and reverence for all forms of life lies with our educational system. Children should be exposed to these principles in the home during early life. This contact can include the media via television and radio, books and magazines as well as parental guidance. One of the most important aspects is to teach children to be responsible for the care of animals—as, for example, with their own house pet. If this could be accomplished we will have reached the first step in preventing the accumulation of and need for mass euthanasia of unwanted dogs, cats, and other pets. The next opportunity for impact on the educational process is at the grade school and high school level. All children and young people should be taught about the basic biology, physiology, and behavior of animals and man, whether or not they intend to become involved with animals in later life. It is only by providing the proper setting and exposure to animals at this level that the scientist of tomorrow will be prepared to design

and execute meaningful and humane experiments on animals. A final point relates to the teaching methods, and qualifications and interests of the teachers. To initiate the challenge to learn and also instill the need for compassion when working with animals is a difficult task. It should be approached with dedication, sincerity, and above all, enthusiasm.

The paper to be presented here discusses noninterventive methods of learning from animals as models for studying physiology and disease. It will be restricted to mammals and will include their use to observe and study evolution, embryology and genetics, as well as the processes of normal physiology, spontaneous disease, aging and death.

Discussion

An important educational purpose is served by teaching reverence for all forms of life. This can start with learning about lower forms including plants, insects and unicellular organisms and progressing up the evolutionary scale to invertebrates, vertebrates and finally to mammals. A classroom introduction to mammals could begin by studying and comparing the behavior of marine mammals with that of terrestrial mammals and man. A variety of teaching methods can be used to exemplify the spectrum of the animal kingdom. These include direct observation and contact by means of classroom demonstrations and local or regional field trips to zoos, aquaria, farms, laboratory animal production facilities, wildlife preserves, humane societies, kennels, purebred animal shows and trails, veterinary clinics and animal training schools. Other techniques utilize communications-media, such as television, radio, books, magazines, films and lectures. Demonstration of normal physiological processes can be accomplished by direct or indirect means such as the study of embryological development in the chick embryo and films of mating behavior, parturition and maternal-neonatal interactions in a variety of species. The principle of genetics can readily be taught or demonstrated with plants and by studying coat color patterns in small laboratory rodents or in purebred dogs and cats.

Normal physiological processes of life and death can be illustrated by taking students to visit laboratory and farm animal production facilities. Observation of the rearing of suckling mice, rats, hamsters, guinea pigs, and rabbits in modern husbandry facilities gives the student an opportunity to appreciate humane care of laboratory animals, many of which are raised for use in biomedical research. Similarly a farm facility that produces livestock can illustrate lambing, kidding, and the hatching of newborn chicks, turkey poults and goslings.

Companion animals such as dogs and cats serve in the home and school as examples of the social interactions between people of different backgrounds and animals. Many young people have a family pet and have learned about life from watching and being involved in the birth and neonatal rearing of puppies and kittens. A common bond exists amongst peoples who love and work with animals and other forms of life. To a considerable degree rural and urban community life revolves around interactions with living things and hence these have significant impact.

Because of their shorter lifespan, various animal species provide excellent examples of the natural processes of aging and death. Too often the youngsters of today are shielded from exposure to disease, suffering, and death, and thus are completely unprepared to face this eventuality with their own pet, loved one or friend. Teaching the inevitability of death can be more easily accepted if the student learns respect and

compassion for all types of living things. Expression of grief under such circumstances should be encouraged as a normal emotional release.

A final and important educational opportunity is afforded by studying the naturally occurring inherited and acquired diseases of animals as well as the evolutionary differences between species as models for the analogous human situation. In this regard, the field of comparative hemostasis provides many examples which can be used as a powerful learning device. The following is a brief description of some select examples.

All mammalian species studied to date have similar patterns and molecular weights of their platelet membrane glycoproteins with the exception of both wild and domestic members of the cat family (*Felidae*). None of these *Felidae* have detectable amounts of the major glycoprotein called glycoprotein I. This membrane component is thought to play a major role in platelet-blood vessel wall interaction, but apparently members of the cat family can function perfectly well without it. This and other species specific differences in platelet function have recently been reviewed by Dodds (1978a).

Sequencing analysis of the fibrinogen molecule of a variety of mammalian and nonmammalian species has revealed specific family-related differences, which permits extrapolation to the ancestral relationships between the various vertebrate and invertebrate classes (Gaffney, 1977; Doolittle, 1977). Similarly measurements of the relative activities and immunologic cross-reactions of identity, partial identity and non-identity between the clotting factor proteins of man and other mammals compares the activity and antigenic similarities and differences between these molecules (Bennett and Ratnoff, 1973; Ratnoff, 1977; Hawkey, 1976).

Acquired hemostatic disorders are recognized in both man and animals. The pathophysiology of these diseases is similar or identical in all species. For example, the infectious, metabolic, neoplastic, autoimmune and drug-induced causes of hemorrhagic tendencies have a common etiology and pathogenesis in a variety of mammals (Dodds, 1974; Dodds et al., 1977; Raymond and Dodds, 1979).

Much more information is available on the inherited hemorrhagic diseases of animals than exists for acquired problems. Animal models have been recognized for nearly all of the coagulation and platelet function defects of humans (Dodds, 1974; Dodds, 1978b). The most common of these are the hemophilias (types A and B), which occur in nearly all purebreds of dogs, mongrel dogs, cats, and standard and thoroughbred horses, and von Willebrand's disease (VWD) which has been recognized in Poland-China swine, in six inbred families of purebred dogs, and in other isolated cases involving various breeds. The prevalence of the gene for VWD amongst inbred dog families is as high as 30-40% in Scottish terriers and Pembroke Welsh corgis and is more than 60% in Doberman pinschers. These genetic defects and their demographics in animal populations can be used to teach students the consequences of selection by intensive inbreeding and linebreeding.

Students can visit colonies of animals with such chronic genetic diseases and become volunteers to help with routine care, exercise and grooming. This affords a better appreciation of the complete dependency these animals have upon humans. Without someone to recognize and treat bleeding episodes when they begin, affected animals are helpless to protect themselves. Compassion for life and a dedication to the alleviance of suffering are easily developed by such an experience. In addition the students are performing an important and useful function as the emotional well-being of the afflicted animal is clearly enhanced by the attention, affection and social inter-

action. At the same time the reality of the serious nature of these genetic defects and the potential for severe illness or sudden death should be understood. The student can then appreciate that the best we hope for is to make what life these animals have as happy and meaningful as possible, while we learn from studying the natural course of their disease.

The above discussion illustrates one of many specific examples where animals with inherited diseases analogous to those of man can provide a challenging educational experience for the student.

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Reverence for Life: An Ethic for High School Biology Curricula

George K. Russell

Abstract

Ethical and pedagogical arguments are presented against the use of animals by high school students in experiments causing pain/suffering/death of the animal. No justification is seen for such experimentation when perfectly valid alternatives, using noninvasive techniques, exist or could be developed. An important concern is the emotional and psychological growth of young people. An overall objective of high school biology curricula must be to assist students in making viable connections with living biological processes and the natural world.

Introduction

In recent years, it has become increasingly common for high school biology students to make use of experimental procedures causing pain, suffering, and, in many cases, the death of vertebrate animals. Test reactions to toxic chemicals, deprivation diets, frog pithing and the removal of internal organs for physiological study, and other procedures have led to a growing concern among educators about the ethical and pedagogical value of these methods. To be sure, a commitment to "hands-on" learning and "inquiry-oriented" laboratory work is to be supported and encouraged, but at the same time one must seriously consider what is actually being done in the classroom and how it is done. The provision of living animals in high school classes for purposes of vivisection, for example, cannot be justified simply on the basis of an experiential learning approach; other more important aspects, including the humane treatment of sentient creatures and the emotional and psychological growth of young people, should be of much greater concern.

Reverence for Life: An Ethic for High School Biology

Thorough analysis of the relevant philosophical issues lies beyond the intended scope of this paper, but I should like to offer a fundamental ethical precept, which, I believe, could form the basis of a truly humane concern for vertebrate organisms in high school biology curricula. It is Albert Schweitzer's ethic of "reverence for life."

If (a human being) has been touched by the ethic of Reverence for Life, he injures and destroys life only under a necessity which he cannot avoid, and never from thoughtlessness. So far as he is a free man, he uses every oppor-

tunity of tasting the blessedness of being able to assist life and avert it from suffering and destruction (Schweitzer, 1949).

The central notion here is the phrase, "only under a necessity." Whatever views one has on the use of animals in advanced biomedical and scientific research, it is clear that no demonstrable necessity exists to justify infliction of pain or the killing of vertebrate animals in high schools, especially when humane alternatives exist or could be worked out. Indeed, in every instance where animals are "sacrificed" for some particular purpose, the burden of proof lies with those who advocate the taking of animal life to prove necessity. It is the principal contention of this paper that the cognitive education of young people in the high school biology curriculum can be fully satisfied without the need for destructive animal experiments, and that the emotional and aesthetic growth of high school students, so little considered in education today, can be deeply enriched and nurtured by a commitment to the preservation of animal life.

Pedagogical Considerations

Several arguments are advanced to justify the use of animal experimentation in high schools. Many teachers favoring the development of experiential learning hold the view that teaching is enhanced by providing "living material" for students' use. As a general proposition this may well be true, but in actual practice it depends entirely on how the organisms are used and the attitude the instructor adopts toward them. An experiment in which the brain of a frog is destroyed in order to study spinal reflexes or the beating of the animal's heart demonstrates very little that could not be found in any elementary textbook and is a troubling experience for a student of even modest sensibilities. On the other hand, one can learn a surprisingly large amount about a frog by quietly observing its rate of respiration, feeding habits, and the structure of its tympanic membrane. In addition, an imaginative teacher could make good use of transparent organisms (various species of fish and invertebrate organisms) to demonstrate living processes in living animals. It seems to me that one must always keep firmly in mind what the exercise is supposed to be demonstrating. Does the result in any way justify killing or the suffering inflicted on a living creature? (Russell, 1972).

Many of the animal studies carried out by high school students are not experiments at all. As simple demonstrations they do not meet the educational objective for students to conduct inquiry-oriented laboratory study. The late Joseph Wood Krutch called attention to the cruel and pointless nature of many so-called investigations in which animals are starved, infected or manipulated so that students can witness at first hand the effects of experimental procedures, the results of which are already well-known to them in advance. With reference to deprivation diet studies Krutch (1956) wrote the following:

By now it is as well known that a rat will sicken and die without certain foods and vitamins as it is that he will die if given no food at all. Would any one learn anything by poking out the eyes in order to prove that without them animals can't see? . . . Taught by such methods, biology not only fails to promote reverence for life, but encourages the tendency to blaspheme it. Instead of increasing empathy it destroys it. Instead of enlarging our sympathy it hardens the heart.

In no way do these studies give the students a true experience of research or the joy of discovery, nor do they develop the scientific imaginations of young people. Krutch's argument applies, I believe, to a great deal of the animal work performed in high schools today.

Animal experiments in scientific and biomedical research have been justified by their contribution to the advancement of human knowledge. The advances in physiology and medicine and through the use of animal experimentation, for example, have been very substantial indeed, but the question here concerns pedagogy, not research. No single experiment in high school advances human knowledge in the slightest.

Special emphasis is often placed on the need for vivisection and other forms of invasive animal experimentation in high schools to interest young people in medical and scientific careers.* In my opinion, this notion has been greatly overstated, particularly in the premedical area. Has it been clearly demonstrated, for example, that career choices in human or animal medicine are specifically promoted in high school children by starvation of animals or the dissection of living tissues? The available evidence suggests that young people develop an interest in health related careers from personal experience with serious illness, part-time employment with a vet or in a health clinic, or from a deeper, idealistic commitment to a helping profession. Surely, one wishes to nurture the medical and scientific interests of young people, but not at the expense of their compassion and devotion to life itself. And what of the many young people of superior qualifications who, disheartened and disaffected, have turned to other professions because they could not reconcile the infliction of pain, suffering or death in high school experiments with their interest in healing and the preservation of life. I am personally acquainted with several. In my view, premedical education at the high school level would be performing a far greater service by fostering veneration and compassion for life. In an age of specialization, when many physicians are more interested in the disease than in the welfare of the patient, compassion and a personal commitment to human and animal well-being are just as important as diagnostic, therapeutic and technical skills. A prospective surgeon or veterinarian may have to perform animal experimentation during his medical training, but a compelling case has not been made for this to be an essential part of the high school biology curriculum.

The psychological effects of vivisection and invasive animal experimentation on the personality of a young person cannot be overemphasized. In no way does vivisection make a young person better, more capable or more humane. My opposition to so many of the student experiments is based on a concern for the humane treatment of animals and, equally, a concern for the emotional and mental health of the students (Russell, 1972). Commenting on this aspect of animal experimentation in schools, F. Barbara Orlans (1970) has written the following:

Recognizing that youngsters can be emotionally upset by seeing others injure animals, many school districts require that no animals be killed in the presence of pupils. When a student himself hurts or kills an animal, the experience may be either traumatic or emotionally desensitizing. Many high school students

*Of the approximately three million students who take high school biology each year in the United States, only a very small percentage goes on to professional careers in biology or the health sciences. I have often observed that discussions on animal experimentation in high school biology curricula focus too much on the preprofessional students and too little on the overall educational aims for ordinary students, half of whom will never take another science course in their educational careers.

cannot bring themselves to harm animals as it is against their natural feelings, and they are seriously troubled over the moral problems involved when others hurt or kill living beings. Surely it is of paramount importance that a child be protected from violent experiences that are psychologically disturbing.

For many young people, harmful animal experimentation leads to insensitivity, callousness and a progressive crippling of the capacity for feeling. A student who is ready to inflict unnecessary suffering on defenseless animals will certainly be capable of doing the same to human beings. Even if the perception of others as belonging to his own kind restrains him from actual physical abuse, he is likely, I believe, to be insensitive, impersonal and selfish in his dealings with other people. Furthermore, destructive animal work in the classroom impairs a young person's emotional development by teaching him to "rationalize and condone the unjustified inflicting of pain" (Stevens, 1970). The ordinary student who is not continuing into a medical or biological career is hardened and made less humane if his high school studies harm animals; the prospective biologist or medical researcher is impoverished by his lack of sensitivity (Stevens, 1970). Surely, as educators, we have a major responsibility to help young people awaken respect for life and to develop love and admiration for all living things.

It may seem that I have unduly stressed the role of education in fostering the feeling life of students, for education is said to be concerned above all with intellectual growth. Many young people, however, are rather indifferent to academic subject matter and lack genuine enthusiasm for the serious study of natural phenomena. This lukewarm interest, I believe, is caused in part by an overemphasis on unnecessarily abstract mechanistic explanations and too little emphasis on careful observation and first-hand acquaintance with the actual subject matter under consideration. It is essential that students feel inwardly connected with the material they study. A student can begin to understand the "personality" of a species of bird or mammal from patient observation of its life-habits without even knowing the common name of the animal. Only when he has achieved a familiarity based on respect and a sense of kinship can he pursue a true course of intellectual study. Many high school students have little affective connection with the natural world and what concerns me greatly is that cruel or destructive animal experimentation severs the very tenuous connection that does exist, thus making real learning and a viable connection with nature impossible. A student will eagerly learn the names, parts, and processes of plants and animals for which he feels admiration and a sense of wonder (Russell, 1972).

Many young people actively seek ideals by which they can meaningfully conduct their lives in what they see as a troubled and uncertain world. Surely, deeply felt compassion for sentient life and a commitment to the protection of defenseless creatures can help young people to build stable and harmonious personalities, and bring a force of devotion and healing to a world greatly in need of it. A recent editorial (Christian Science Monitor, 1978) summarizes it so very well:

In the deepest sense, the issue (of animal experimentation) has a bearing on the kind of moral environment that is fostered. Surely humaneness toward animals as well as men, a reverence for the life of all creatures, is an essential ingredient of that high ethical tone that marks any civilized society. As scientists who have turned away from animal experimentation argue, the best way to use animals to help humans is to teach people to love.

Humane Alternatives: A Challenge

One must recognize the legitimate need to provide meaningful laboratory experiences for high school students in science fairs, after-school science clubs, and within the ordinary biology curriculum itself. True inquiry-oriented laboratory study gives all high school students a basic understanding of the scientific process, and allows those students, contemplating careers in the biological sciences, to deepen their interests and to investigate natural phenomena in a manner that is both intellectually rewarding and scientifically sound. I firmly believe that these aims can be fully satisfied with humane alternatives that involve no killing or animal suffering. To this end I offer the following list of studies and approaches. The list represents only a broad outline of possible student investigations, and it will serve, I hope, as a challenge for the development of many more. Indeed, if even a fraction of the effort expended so far in devising student experiments could be directed to the imaginative development of humane alternatives, we would soon possess a rich and varied selection of procedures, approaches and meaningful avenues of study.

(1) Use of plant pathogens to illustrate the principles and techniques needed to prove that microbes act as causative agents of disease (Koch's postulates)—The role of microbes in the causation of disease and the specific procedures by which one proves that a particular microbe causes a specific disease (Koch's postulates), can be thoroughly investigated with plant pathogens. As a simple example, soft rot disease of carrots caused by the bacterium, *Erwinia carotovora*, can be studied with very little laboratory apparatus, and the essential features of Koch's postulates thoroughly investigated (Hogue, 1971); procedures of this type provide first-hand knowledge of basic microbiological techniques and their role in studying infectious disease. Analogies can easily be drawn to animal and human disease, and videotapes and films may be used to provide clear demonstrations of clinical symptoms. In brief, one need not present high school children with morbid animals to teach them about disease.

(2) Physiological studies of a wide variety using the students as experimental subjects—It is of particular interest that physiological studies with the students themselves are coming to play an increasingly important role in American medical school education.

There seems to be a trend toward utilizing experiments that can be done on humans and minimizing those done on animals. One reason given is that the student being introduced to bedside teaching early in medical school receives practical demonstration of physiology at the bedside and has much less interest in performing experiments. These labs have offerings of physical diagnosis, pulmonary function tests, electroencephalograms and ECG readings, exercise physiology, special senses and many others using the students themselves as subjects. (Poland et al., 1975)

The following list presents some of the physiological studies that can be carried out by high school students: measurement of blood pressure and cardiovascular status, simple electrocardiography, the galvanic skin response, respiratory processes, exercise physiology and the measurement of physiological parameters during physical training, circadian rhythms, sensory processes, urinalysis, human nutrition, studies on

the blood, and many others. As the author of a college-level laboratory manual in human physiology using noninvasive techniques (Russell, 1978), I can state without reservation that students are eager to participate in studies of this kind and, at the introductory level, learn just as much physiology as they would through destructive animal experiments. As newer forms of educational equipment become available, the range of these experiments should expand considerably, especially at the high school level.

(3) Use of mechanical models to investigate physical principles involved in biological processes—One could offer many suggestions here, but I shall mention only one, the use of mechanical models to investigate elementary physical principles of the heart and circulation. Two such models (composed of syringes, valves, tubing, etc.) have been described by Greenwald (1975) and Rodbard et al. (1976). With this apparatus, students can investigate principles such as cardiac output, stroke volume, valve action, peripheral resistance to blood flow, and many others, very few of which could be studied with the usual frog heart preparation. Taken together with the student's assessment of his/her EKG, blood pressure, sounds of the heart, and other cardiovascular processes, these studies give the student a thorough basic understanding of the heart's action. In addition, many schools offer excellent courses in basic cardio-pulmonary resuscitation (CPR) with a strong emphasis on practical aspects. This approach lays to rest, I believe, an objection which has frequently been raised to me, i.e., "How can high school students possibly study the workings of the heart without killing animals?"

(4) Use of human cells (skin, peripheral lymphocytes, etc.) grown in tissue culture for the study of human chromosomes—Tissue culture methods and karyotyping, using human cells grown in suitable nutrient media (available in kit form), can be performed by exceptional high school students. In addition, these methods can be modified to study the effects of pharmacological agents, food additives, radiation, etc. on cell growth and chromosome structure. Most importantly, methods of this kind, which play a significant role in biomedical research, give the students a genuine experience of laboratory research.

(5) Biological studies on living animals in the classroom using methods of non-intervention—Numerous worthwhile suggestions have been offered by several authors and many more can be developed. The Animal Welfare Institute (1977) lists many projects, books and references in this area, and recent books by Crum (1974) and Orlans (1977) present hundreds of detailed suggestions for interesting and highly instructive student investigations. To quote from the introduction to *Animal Care From Protozoa to Small Mammals* by F. Barbara Orlans (1977),

Biology teaching should mesh together the teaching of humaneness, kindness and respect for life, with the spirit of objective inquiry. Students normally show a natural interest in and fondness for animals. It is the responsibility of biology teachers to foster that natural curiosity and affection and broaden it into serious study of the understanding of life processes.

Maintaining living organisms, from protozoa to small mammals, is an ideal way to achieve this end. Among the objectives of keeping classroom animals

are an appreciation of all forms of life, an opportunity to observe and perceive and the challenge to develop a spirit of inquiry and reasoning based on a sound sense of values. All of these pursuits are compatible with the thesis that scientific inquiry and respect for life go hand in hand.

(6) **Study of animals in their natural state using methods of nonintervention**—A central aim of all high school teaching of science must be to provide young people with a meaningful experience of nature—minerals, plants, animals, clouds and the weather, geological processes, and the entire natural world—through patient and quiet observation. Many college freshmen of my acquaintance have been deeply moved by a study of Iain Douglas-Hamilton's (1975) work on the elephants of Lake Manyara, Tanzania, Durward Allen (1979) on the wolves and moose of Isle Royale, Lake Superior, Jane van Lawick-Goodall (1971) on the wild chimpanzees of Tanzania, and the more popular writings of Konrad Lorenz, Farley Mowat, John Muir, Robert Franklin Leslie and many others. For these young people, the study of biology has suddenly assumed a new and highly relevant dimension, and they have eagerly sought ways to observe wildlife in their own surroundings—squirrels, rabbits, woodpeckers, chickadees, orb spiders, earthworms and many other forms of life. The ethologists and behavioral ecologists can help us to develop many meaningful observational exercises along these lines. I sincerely believe that a proper study of natural history is a fundamental way to assist young people in developing genuine empathy and respect for the natural world and to aid them in building a devoted, lifelong interest in plants, insects, birds, mammals and all life.

As an educator, I am increasingly aware of the additional responsibilities that are coming to fall within the sphere of science education. As in the past, one must formulate educational objectives dealing with knowledge and skills, but also, more recently, with fundamental questions of value. Never before have young people questioned meanings and values so much as today. In spite of this, there is recent evidence that the actual state of high school biology education in this country is one of "a traditional discipline taught in a traditional way. Biology is primarily scientific content, not social concerns, and biology teaching is basically didactic" (Stake and Easley, 1978). Schweitzer's ethic of reverence for life, as well as a new emphasis in biology teaching based on this ethic, could help to give young people an important foundation for their lives. If biology were taught in a manner that developed a sense of wonder and a feeling of reverence for life, and if students felt inwardly enriched from their study of life, these individuals would formulate as a lifelong goal the steadfast determination to protect and preserve all life, and would, I believe, dedicate themselves to the creation of a better world.

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Pain-infliction in Animal Research*

Dorothy Tennov

Abstract

A summary of research outlining the main sources of pain and stress to animals in laboratories provides the background for the results of a survey conducted by the author on how students feel about experimentation involving animals. The psychological aspects of student reaction to animal experimentation are examined. The conclusion outlines specific recommendations on ways to minimize pain and discomfort of laboratory animals.

Attitudes Toward Pain-infliction in Animal Research

It has been observed that willingness to cause injury or death to others varies with degree of dehumanization of the victim (Bernard *et al.*, 1971), physical proximity (Milgram, 1965), and visibility (Johnson, 1972). Among situations in which pain is commonly inflicted is psychological research using animal subjects. The study reported in this article explores reactions to such research as a function of (1) the species of the animal subject, and (2) a verbal context which stresses either benefits to human beings or painful research procedures.

A brief questionnaire was designed to determine whether, when asked to participate in a pain-infliction animal research project, subjects would consent or refuse primarily (1) on the basis of the pain and discomfort to be experienced by the animal (assuming those phyletically closest to humans would be more likely to experience pain as we know it), or (2) on the basis of evaluation of the species in terms of its relationship and familiarity to human beings. It has been demonstrated that attitudes toward pain infliction vary among human categories (Berkowitz, 1964; Johnson, 1972). Species differentiation was conceived of as analogous to differentiation among human categories as well as of interest in itself.

Subjects were 688 undergraduates from introductory psychology classes. At the beginning of the class session, a one-page flyer was distributed. There were three basic forms: (a) **TORCH**, which began with "Although human beings have undoubtedly benefitted in the process, research animals have been subjected to such extremely painful procedures as burning by blow torch, submersion in scalding water, and extreme unavoidable electric shock," (b) **BENEFIT**, which began with "We would still be in the

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dark ages without the benefits which we have received through research conducted with animals," or (c) **INFORMATION**, which began by requesting information about the subject's academic major, sex, and college class.

All forms contained the following:

We are conducting a series of surveys to determine people's reactions to animal research.

Suppose that you volunteered to assist in the psychological laboratory. When you arrived, you were instructed by the professor who was conducting the research that your task was to administer shock to an animal in a learning situation. You were to operate a switch which turned on the shock whenever you received a signal to do so.

Your reaction would be:

A. I would comply because I feel that there is nothing wrong with inflicting pain on animals when it is done for research purposes. (**COMPLY**)

B. When I discovered that shocking an animal was involved, I would ask for more information about the purpose and usefulness of the research and would participate only if the information I received satisfied me. (**MEANS-ENDS**)

C. Since I had already volunteered, I would go along with it, but I would find it upsetting that I had to shock an animal. (**GO ALONG**)

D. When I discovered that shocking an animal was involved, I would refuse to participate. (**REFUSE**)

Would your reaction have been the same no matter what animal species was involved? If your reaction would be different depending on the species, write the letter of the above alternatives for each of the following: frog, pigeon, rat, hamster; cat, dog, monkey.

Space was left for comments. Twenty-four **TORCH** and **BENEFIT** forms were used for complete counterbalancing of the order in which the alternatives were presented, and the species were listed in phyletic order beginning with "frog" on half the forms and with "monkey" on the other half. All **INFORMATION** forms used the same phyletic order beginning with "frog." All forms were returned anonymously.

Approval of the use of animals in painful research—explicit in the case of **COMPLY**, and implicit in **MEANS ENDS** and **GO ALONG**—was expressed by over 95% of the 688 subjects (Table 1). Of the less than 10% (66 subjects) who selected **REFUSE** as their basic response, 55% (36 subjects) qualified that response in a statement to the effect that they did not actually *disapprove* of research in which pain is inflicted on animals but felt that they, themselves, would personally find it difficult to engage in.

Approval was most frequent for the rat (95%). This was even more than for the frog or pigeon, and it was higher for the monkey (82%) than for the dog (75%).

TABLE 1: Proportion of Ss selecting each category in the three major conditions

	N	COMPLY	GO ALONG	MEANS-ENDS	REFUSE
BENEFIT	117	.231	.060	.632	.077
TORCH	133	.134	.098	.683	.084
INFORMATION	438	.119	.148	.625	.107

That differentiation among human groups with respect to willingness to inflict pain occurs is well known (Johnson, 1972). Military training consists partly of categorization and dehumanization of the group designated "enemy." The animal species of the present study represented levels of "dehumanization" in terms of phyletic level, and they were listed in phyletic order on the questionnaires. Despite this, subjects differentiated on other bases. They were more willing to inflict pain on the phyletically more similar monkey than on the more familiar and "friendly" dog.

The **TORCH** statement, designed to remind subjects of possible horrors of animal research, did not produce an increase in **REFUSE** responses, but the **BENEFIT** statement, which stressed the usefulness of animal research, increased **COMPLY** to almost twice the percentage of the other conditions (Table 1). The most popular response was **MEANS ENDS**, selected by about two-thirds of all subjects.

Sex differences were statistically significant ($X^2 = 32.6$, $df = 3$, $p < .01$). Only 6.3% of females selected **COMPLY** as compared with 17.3% of the males; and 17.5% of the females selected **REFUSE** as compared with only 4.4% of the males (Table 2). A curious additional sex difference occurred in the case of the cat. More male students expressed willingness to inflict electric shock pain on cats than did females. A colleague, speaking from his personal experiences, has suggested that the male's view of the cat stems from male-culture abuse commonly inflicted on cats by boys. The male's responses on the questionnaire, then, can be considered another expression of negative reactions toward a victim (Lerner and Simmons, 1966).

Comparing college classes, **MEANS ENDS** rose from 56% of the Freshmen steadily upward to 73.0% of Sophomores, 77.8% of Juniors, and 82.0% of Seniors, with other responses, especially **GO ALONG**, consistently declining as a function of college class (4.6% of Seniors).

A questionnaire is essentially a kind of opinion poll. It measures less what individual respondents do than what they approve and disapprove of in the abstract. When, in earlier research (Hoffman and Costantini, 1967) 60 college students were faced with the situation described in the questionnaire, actual behavior was not consistent with the responses of at least 70% of the subjects of the present study. As might be predicted from the original Milgram (1963) experiments, all obeyed without protest. No one refused to participate and no one questioned the value of the research. The college students of these studies, representatives of the population from which animal researchers are ultimately drawn, clearly approve of inflicting pain on animal subjects "for research purposes." Furthermore, the disclaimers of many of the subjects who selected **REFUSE** as their overall response reveals *cultural disapproval of expression of concern for the animal subject*.

Some years ago, working in a laboratory using acute animal preparations, I ob-

TABLE 2: Proportion of Ss in INFORMATION condition broken down by subject characteristics of sex, field of study, and college class

SEX	N	COMPLY	GO ALONG	MEANS-ENDS	REFUSE
Females	212	.063	.142	.623	.175
Males	226	.173	.155	.629	.044
FIELD OF STUDY					
Education	118	.042	.051	.737	.170
Science/Nursing/					
Psychology	57	.246	.088	.562	.105
Other Fields	256	.101	.210	.607	.082
CLASS					
Freshmen	226	.109	.219	.560	.124
Sophomores	78	.141	.051	.730	.077
Juniors	58	.086	.034	.778	.103
Seniors	22	.046	.046	.820	.091

served that the animals (mostly dogs) sometimes underwent unnecessary stress and pain as the result of carelessness, hurry and the unpleasant social consequences which followed expression of "overconcern" for the subject. These observations have been confirmed by seven research workers whom I have more recently consulted.

There are at least three separable sources of pain and stress to laboratory animals: (1) pain which is an essential aspect of the independent variable, e.g. an experiment on the effect of punishment on maze performance; (2) pain which is incidental to the independent variable, e.g. post-operative pain in brain lesion research; and (3) pain and discomfort which results from inadequate living and handling conditions, e.g. crowded cages, inadequate diet, and inhumane euthanizing. All research animals may be subjected to the third type of discomfort. Existing ethical codes (e.g., American Psychological Association, Board of Scientific Affairs, 1971) and instructions for laboratory workers (Hergenhahn, 1970; Plutchik, 1968; Matheson *et al.*, 1970; and Silvan, 1966) caution against inadequate maintenance procedures. Medical and physiological research—including psychophysiological research—typically involves secondary discomfort due to surgery or other physical procedures. Ethical codes address themselves primarily to possible abuses arising from secondary and maintenance conditions. However, intrinsic sources of reinforcement in the form of less work and money expended when care is poor, and social punishment of demonstration of concern, puts animals at risk despite verbal codes.

When pain is an independent variable, as it so often is in psychological research (Campbell and Church, 1969), the risks increase. The animals resist removal from the cages, they may suffer the dangers of escape and recapture, they may bite and anger their caretakers leading to further mistreatment. It has been noted that research using

aversive stimulation necessarily differs from research in which only neutral and positive stimulation is used in many ways other than the stimulation received during experimental "trials" (W. Kornsey, personal communication). Recently, researchers in social psychology have suggested that the fact that a person is in pain can lead, in itself, to poorer treatment from others (Lerner and Simmons, 1966), a phenomenon which has also been observed in medical situations where patients who are in pain and where ability of the medical personnel to relieve pain is limited, have been observed to receive poorer and more callous treatment than other patients (A. Rogers, personal communication).

Although ethical regulations limiting and restricting research are an incumbrance to any scientist, they afford some protection to research subjects. Over nine years of teaching courses in Experimental Psychology, I have noted the regularity with which college students, when asked to design an independent project, think first of a procedure in which laboratory rats are submitted to electric shock or human beings are made to feel anxious and tense. The students seem less to be sadistic than fearful themselves. They want something which will "work." There is some reinforcement in the very process of initiating a reaction. Turn on the grid and the rat leaps into the air! This is more immediately reinforcing than administering a food pellet.

Because of (1) the cultural acceptance of research involving aversive stimulation to animals ("antivivisectionists" are a tiny minority), (2) the reinforcement that results from the immediacy and visibility of the effect of aversive stimulation for the experimenter, and (3) the social punishment that one may be subjected to for expressing concern for the animal in many laboratory situations, it is recommended that:

A. Mature and experienced psychologists act as role models by making great distinction between animal research that involves pain and discomfort, and research that does not. There should be nothing casual about the decision to use shock or to use positive reinforcement. The latter should always be preferred unless compelling circumstances demand the use of aversive stimulation.

B. The use of electric shock or other aversive techniques should not be permitted to students whose research projects are conducted merely for training in research methodology, to inexperienced investigators, or as classroom demonstrations, unless, again, there is compelling justification.

C. All researchers using aversive procedures should be registered with the American Psychological Association National Headquarters. For almost 100 years, the British have required experimenters using painful procedures to obtain permission. Registering will help to avoid duplication. It will also attest to the seriousness of such research and dispel the notion that inflicting pain on a research animal is acceptable in any research context.

D. Better training and more stringent licensing of animal researchers would help to ensure that animal care is generally improved. There now exist laboratories which have adopted excellent procedures for the protection of animal subjects, but abuses exist in many others. Although most of the abuse is not the result of deliberate mistreatment in research laboratories, fun-and-games cruelties are sometimes indulged in by persons assigned the tedium of animal care. Laboratory animals may also be neglected during university vacation periods.

E. Finally, I urge that our ultimate authorities, the editors of journals and those responsible for the selection of papers to be read at scientific meetings adopt more stringent criteria for acceptance of research reports in which aversive stimulation has been utilized or in which animals suffered secondary sources of pain and discomfort. Was the particular procedure used essential in terms of the research question the experiment was designed to answer? Did, in other words, the ends justify the means? A full explanation justifying the procedures should be part of the published research report.

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SESSION II

The Use of Vertebrates in Biology Classes

CHAIRMAN: MICHAEL W. FOX



Secondary and Elementary School Use of Live and Preserved Animals

Marvin B. Emmons

Abstract

The broad use of living animals in elementary and junior school programs that are currently in vogue will be discussed as well as their use in biology classrooms at the senior high level. A comparison will be made of the present use of animals in the biology curriculum at the high school level, both living and preserved, with the use levels some ten and fifteen years ago. The implications of wildlife habitat encroachment and subsequent depletion of native species of classic animal models as well as some alternatives will be reviewed.

Introduction

The heavy influence of federal funds on the development of science curriculum, following the launching of Sputnik in the late 1950's, resulted in a rather profound influence on the use of living and preserved animals in the teaching of life sciences in both secondary and elementary applications.

Thorough and massive examination of existing science curricula was made possible with this outpouring of money. Educators, brought together through federally supported summer workshop experiences with teacher-consultants, developed new formats for teaching all sciences below the college level. This massive effort involved thousands of teachers, administrators, and federal consultants over a period of eight to ten years. The result was a new series of curriculum materials. These curriculum materials were often referred to as the Alphabet Soup Curricula: BSCS (Biological Sciences Curriculum Study), being one of the more popular life sciences; PSSC, a physics program; and SCIS, an elementary science program, to illustrate a few.

Prior to 1960, live animals were used only on a limited basis in secondary biology, and rarely used on any formal basis in elementary school programs. The occasional inclusion of goldfish in the classroom, or breeding a pair of hamsters, was about the extent to which most elementary teachers would voluntarily get involved with either life science education or the problems of handling live animals in the classroom.

There are only about 4,800 colleges in this country, and not all teach or require courses in biology. 34,000 junior/senior high schools are now present and a majority of those do require biology courses for graduation (Nasco Data Files). Traditionally, high school biology classes usually included some form of dissection, generally limited to the dissection of the frog and fish as vertebrate representatives, sometimes including

the earthworm, clam or starfish as invertebrates. Prior to 1960, only college level courses in comparative anatomy tended to include animals like the fetal pig, dogfish shark or cat.

Following the establishment of the BSCS curriculum, many high schools instituted advanced biological studies including major dissection in mammals such as the cat, mink, and fetal pig, along with an increase in the use of living animals and plants.

One concept in the philosophy of BSCS was that general biology instruction, a life science, should involve greater use of living materials in the classroom. Students should be more involved with life processes and activities as a way to better understand the role of living organisms in their environment. Many aspects of this program were exceedingly expensive in terms of taxpayers' dollars, student and teacher time, as well as placing heavy demands on field populations through direct collection of organisms.

Effect on Animal Populations

Probably the animal whose field population suffered the most was the grass frog, *Rana pipiens*. It was used in activities involving nerve responses, embryology and reproduction, and behavior (including the effects of temperature and orientation, as well as feeding responses). Other demonstrations included the effect of chemical stimuli (hormone treatment) on heart rate and flow of blood. Many of these same animals were subsequently sacrificed to observe other life functions after being deeply anesthetized or pithed, much of this dissection being preferred in BSCS curriculum over the classic dissection of the preserved frog.

The detrimental effect on the size of field collections of *Rana pipiens* populations occasioned by heavy use, has been documented in other publications (see below). The degree to which overcollection, or the effect of herbicides and environmental modification in the collecting grounds, served to reduce the population is open to some discussion at the present time. It appears, however, that in some areas of the country, some of the frog populations are making a comeback, which is coincident both with the elimination of some insecticides, restriction on some herbicides, and a now reduced demand for live frogs for instructional use.

U.S. suppliers, in 1969, shipped approximately nine million frogs (or 360 tons) for educational and research purposes alone. The educational demand arose from both an increased student population and from the introduction of new and improved textbooks, such as the BSCS series. The four major suppliers at that time—Steinhilber (Oshkosh, Wisconsin), Lemberger (Oshkosh, Wisconsin), Schettler (Stillwater, Minnesota), and Mumley (Alburg, Vermont)—either directly or indirectly accounted for about two-thirds of that annual volume. The organization represented by myself (Nasco-Steinhilber Company), that year processed approximately 80 tons or nearly two million frogs. Of this tonnage, 50-60% were shipped as living material, and the rest as preserved for use as special preparations, a ratio believed to be typical of the industry as a whole (Gibbs et al., 1971).

Another publication, *Modern Medicine* (1973), reflected a cataclysmic decline in the availability of *Rana pipiens* following 1972.

In 1971, three major suppliers lost nearly 90 percent of their stock and many of the other suppliers lost around one-half of their supplies; and all suppliers had larger than average losses in 1972, according to Dr. George W. Nace, director of the Amphibian Facility at the University of Michigan-Ann Arbor. Nasco's collection had also dropped during this period from more than 30 tons of frogs (almost one million frogs) in an average year, to only five tons in 1972 (Modern Medicine, 1973).

As the price of field collected animals has skyrocketed, in many cases by a factor of 10 or more, reexamination of goals and rationales seem to be occurring on a national basis. With the broader awareness of environmental considerations, many biology students and teachers are beginning to question the wholesale slaughter of great numbers of animals for the purpose of instruction, and question whether similar factual material could not be learned in a manner less costly to these wild populations.

Presently, there seems to be a decline in the use of live material. To what extent due to increased sensitivity and to what extent due to increases in cost and decreases in budgets is difficult to determine.

One of the alarming things about this entire federally funded program, was the rate at which implementation through federally funded workshops and institutions were able to instate this curriculum in more than 80% of the schools in something less than ten years from conception to implementation.

In the early 1960's, a similar federally funded curriculum development resulted in the Science Curriculum Improvement Study (SCIS), which brought the level of involvement of live animals down to the elementary classroom. Many of these activities were imaginative and of interest to youngsters when properly presented.

The biggest impediment to the implementation of these programs was the general lack of background among elementary teachers in the areas of science in general, as well as the specific requirements for proper maintenance of live animals in a classroom environment.

Again, extensive federally funded institutions and workshops, followed by private funding (Rand McNally, who purchased the rights initially to the SCIS program), were able to accomplish in a few short years the greatest single modification of elementary science instruction in the history of education. The SCIS program involved quantities of guppies, tadpoles, fruit flies, land snails, crickets, sowbugs, and literally millions of dollars worth of material on an annual basis.

Without adequate supervisory support and practical assistance, these programs became increasingly difficult to sustain. After being implemented in a great majority of elementary school districts in the country through the early 1970's, we find now a shift toward more conservative use of live animals at these levels.

Incidentally, in the early development of the SCIS program, very little attention was paid to the dissemination by elementary students of potentially damaging populations of organisms, the snail, *Helix aspersa*, being the largest offender. Very often they were released into local areas (parks, streams or school yards) at the conclusion of class activities. These animals are now creating feral populations in strange distribution patterns around the country. Only in the last few years has action been taken to limit this form of animal introduction.

The author also serves as editor for the "Biologic" Newsletter, published by Nasco, and mailed to thousands of teachers of science and biology. Last spring's issue, Volume 3, Number 3, included a reference to the meeting of the Institute for the Study

of Animal Problems in Washington September, 1979. Not one response has been forthcoming from the academic community. Surprisingly, two responses have come from secondary school students, both excerpted here.

... I think that biologists should be the only ones to experiment with animals. I think if the high schools want preserved animals to dissect fine. Probably over half of the science teachers aren't sure how to care for the animals. My science teacher did an experiment with gerbils. After the experiment was over, the animals just sat there in their cages. Most of the cages were filthy. They kept breeding and finally he had to give them away. (Richard Harland, Louisville, KY.)

I am a science research student at Beach Channel High School, who recently undertook a project involving the effect of extremely low dosages of caffeine on a mouse's ability to run through a maze, and to adapt to light. Out of the 15 mice I used in my experiment, there were no deaths; and after the end of the experiment, there were over 22 births. Because of an outdated rule, my project is banned from the Westinghouse Fair, one of the most prestigious fairs in the country. I do not feel my project should be banned, when other projects involving extreme cruelty to invertebrates are allowed. (R. Schroeder, New York, NY.)

Conclusion

Surely the use of some live animals in the classroom is not unreasonable. Today, youngsters need to become actively involved in the learning/discovery process. Use of live material sustains greater interest, provides greater motivation, and probably assures more permanent retention.

Regulation of activities will continue to be important. Attitudes displayed by the teacher do create a learning experience intentionally or not, negative or positive towards the advance of humane attitudes.

I would like to see an orderly progression of limitations, disseminated through teaching journals, workshops, etc., and avoiding extremist positions. This could be accomplished by enlisting cooperation of teacher training institutes and industrial sponsors, Westinghouse and others, in establishing a uniform set of standards for live animal use.

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Understanding and Attitudes Derived from the Use of Animals in Schools*

Peter J. Kelly

Abstract

A general review of the variety of activities involving the direct use of animals which are undertaken in secondary schools. An assessment is made of their value (positive and negative) in terms of knowledge and attitudes (including ethics) which are, or might be, derived from them. Alternative methods also are reviewed with an assessment of their value in relation to live animal studies.

The British Context

British schools have a long tradition of keeping and of using animals. This has its roots in the nineteenth century attitude portrayed, for example, by Robert Patterson in his book *An Introduction to Zoology* published in 1848 where he says: "The great object should be to bring natural history knowledge home to the personal experience of the pupil . . . Small collections of objects made by the pupils themselves would, under the guidance of a judicious teacher, be of great value in this species of mental culture and would form the much-prized ornaments of the school room." No biology room or laboratory since seems to have been without its geranium plant, skeleton, aquarium and the inevitable pet mouse, rat, rabbit or guinea pig. The type system of teaching zoology initiated by Thomas Henry Huxley reinforced the tradition. In this a limited set of species representing the major phyla^a is studied and a display in the laboratory of living animals, dead specimens and their parts, and pictures of the species is a frequent accompaniment.

This Victorian legacy still hangs on to some extent but in recent years it has been modified by several influences, including the curriculum development projects of the nineteen sixties, which have broadened the scope of biology teaching beyond taxonomy, morphology and physiology to include behaviour, ecology, genetics and other aspects of the subject. In particular, the human species has become an increasingly important focus of interest.

These projects have tended to enhance the status of practical work, especially

*This paper is an edited version of "Organisms in Schools: Retrospect and Prospect", published in *The Educational Use of Living Organisms: A Source Book*. P.J. Kelly and J.D. Wray, eds., 1975, English Universities Press, London, U.K.

that which involves experiments and encourages pupils to explore, observe and be creative. The development of attitudes toward living organisms has also become an increasingly prominent educational objective expressed in such phrases as "To encourage a respect and feeling for all living things" which is one of the aspirations of the Nuffield O-level biology project.

In 1974 a Working Party of the Schools Council (an institution concerned with developing new curricula and examinations and governed by representatives of teachers' professional organizations, local education authorities and the national Department of Education and Science) drew up a list of aims for the educational use of living organisms (Schools Council, 1974). It was approved by an extensive body of opinion and depicts clearly the broad perspectives that provide the framework for present-day thinking:

To provide a source of inherently interesting material which can be used to arouse and encourage an attitude of controlled curiosity and inquiry.

To provide the opportunity for personal experience in observing and investigating living organisms, their diversity, their variation, their inter-relationships and life processes.

To inspire and encourage creative work in a variety of disciplines.

To promote an understanding of some of the concepts of biology and of the processes associated with life.

To identify and to examine those factors in the immediate environment of living organisms which affect them and to develop an understanding of the relationships between living organisms and their environment.

To promote an understanding of the relationship between man and other living organisms; of his dependence on many living organisms; of the reason for his exploitation of certain living organisms for food and for other needs; and of his competition with pests and predators.

To develop sensitivity to and consideration for the needs of living organisms.

To emphasise that man as a living organism has certain needs and to encourage an attitude of thoughtfulness and consideration when dealing with other human beings.

To encourage an attitude of concern about the conservation of natural environments in which living organisms may thrive and an awareness of the problems associated with conservation.

To develop an aesthetic appreciation of the colour, form and movement associated with living organisms and of the enjoyment of them.

To give information about and experience in the necessary skills involved in the techniques of care and management of living organisms.

To impress by showing that, when it is necessary to kill animals, for whatever reason, the most humane methods are always used.

A survey by the Schools Council's Educational Use of Living Organisms (EULO) project in 1970 found a range of over 100 species (or groups) being used in secondary schools (Kelly and Wray, 1971). Thirty-one of these were vertebrates. In order of the percentage of schools using them the most prevalent vertebrate species were the common frog (81%), mouse (68%), newt (63%), goldfish (54%), gerbil (54%), guppy (50%), common toad (45%), rat (44%), guinea pig (41%) and rabbit (41%). Thirty-three percent were using the Nuffield O-level biology materials, at least in part. Smaller proportions were using courses from other curriculum development projects initiated in the nineteen sixties. Thirty-three percent of the schools had Natural History or Biological Societies, 12% had Pet Clubs and 63% used organisms in informal, extra-curricular activities with pupils. Predominantly organisms were used for scientific work, rarely as foci of interest in other subjects or for therapeutic purposes.

Although scientific studies were cited as the main context in which organisms are used, this tended to be chiefly concerned with descriptive studies rather than experiments. It is in the Nuffield biology courses that the latter occur most but, as Table 1

Table 1: Use of living (or freshly killed) material in the Nuffield biology courses†

	% of exercises involving living material	Relative use of the main groups of living organisms expressed as a percentage	
		Invertebrates	Vertebrates‡
Nuffield O-Level			
Year 1 Introducing Living Things	85	44	42 (H = 4)
Year 2 Life and Living Processes	60	5	10 (H = 2)
Year 3 The Maintenance of Life	73	15	17 (H = 14)
Year 4 Living Things in Action	73	25	25 (H = 14)
Year 5 The Perpetuation of Life	72	26	28 (H = 11)
Average use overall	72	23	24 (H = 10)
Nuffield A-Level			
Maintenance of the Organism	61	28	13 (H = 5)
Organisms and Populations	89	34	8 (H = 3)
The Developing Organism	71	6	22 (H = 3)
Control and Co-ordination	82	18	32 (H = 6)
Average use overall	75	22	18 H = 4)

†Excludes communities where individual species were not noted, and all blood except human blood.
‡H = Use of the human species.

(Dowdeswell, 1975) indicates, the number of activities using vertebrates is, in fact, small, and among the vertebrate species used the pupils themselves figure prominently.

There is certainly no reason to suspect that the use of organisms has increased since these studies were made. The economic vicissitudes which have beset the education system over the last five years have allowed little room for expansion.

Overall, then, the position in Britain can be summarized as being one in which there is a tradition of using living things in education; in which the use of living organisms is now limited to a wide range of educational aims; in which most secondary schools use organisms, especially for descriptive work in science (biology) lessons; and in which the use of vertebrates for experimental studies is small.

To complete the picture two other matters should be mentioned. The first is that there are legal and moral constraints on the use of vertebrates in the form of the Cruelty to Animals Act of 1876 and the Protection of Animals Act 1911. The latter is the principal statute and states that it is an offense to "cruelly beat, kick or ill-treat, over-ride, over-drive, over-load, torture, infuriate or terrify any animal" or "by wantonly or unreasonably doing or omitting to do any act . . . cause unnecessary suffering, or being the owner, permit any unnecessary suffering to be so caused to any animal." Other sections of this Act make it an offence to convey any animal in a way that causes unnecessary suffering, or to "wilfully, without any reasonable cause or excuse, administer, or cause . . . such administration of any poisonous or injurious drug or substance to any animal . . .", or to subject "any animal to any operation which is performed without due care and humanity" (O'Donoghue, 1975). Because of these constraints vivisection and cruelty to animals in schools is "officially" non-existent. Unofficially it is still rare, occurring mainly as a result of negligence or accident. Providing a non-legal framework for the use of animals in schools is a detailed code of practice produced by the Schools Council (1974) and a variety of publications produced by the Department of Education and Science.

Finally, it is important to mention a backlash effect inhibiting the use of living organisms which has occurred in recent years. Following the curriculum developments in the sixties which inspired a greater use of animals in schools, projects, such as the EULO project, were established to provide advice on the value of using organisms, on their maintenance, and on the health, legal and other implications of using them. This work was intended to facilitate and encourage the use of organisms in an educationally and ethically valid manner. However, in some quarters it has been seen in quite the opposite way. The need for increased resources and the realisation of potential health hazards, for example, have been perceived in an exaggerated fashion and used as arguments for preventing organisms being used in schools. Such contortions of intention into practice indicate the sensitivity of the balance of attitudes of teachers, administrators, politicians, parents and others which decide whether or not, and how, animals are used in schools.

A Framework for Discussion

The problem of determining the understanding and attitudes which may be derived from the use of animals in schools is an educational issue. It needs to be distinguished from the contexts of ideological and political issues in which it is inevitably found and with which it is inevitably confused. For example, discussion based on propositions such as "Animal life is sacred to each species; confining animals is wrong,

therefore young people should not deal with animals in a captive state," or "the preservation of human life is the paramount virtue; this inevitably is harmful to other animals, therefore, young people should be educated to accept this" consider the ideological (moral, if you like) determinants of whether or not you place animals in schools. This is an important cultural discussion but not, *per se*, an educational one. The educational issue presupposes animals are in schools, or some other educational context, and asks questions about the teaching and learning methods and about the effects pupils derive from the education they undertake with the animals.

Another distinction to make is between the very specific case of using animals for investigations in which there is a high probability that they experience pain or harmful discomfort, the case of killing animals (e.g. for dissection), and the case of other forms of using animals which have no intentional consequence of cruelty or death. The understanding and attitudes and, of course, moral perspectives involved in each of these three cases are of quite a different order.

Yet further distinctions, which it is important to bear in mind, are those between different types of pupils and different types of school and cultural setting. Age and sex differences in pupils' attitudes to animals have been detected by research and are known through experience by teachers and parents.* The influence of social background and peer group pressures on the attitudes and behaviour of young people are well known and, again, will produce a variable effect.

Any judgements on the value of animals in education will have to take these considerations into account. They suggest that it will be unlikely that we are able to make any grand generalizations.

Generalization is also difficult because, at least in Britain, there is insufficient variety of experience of using animals in schools and, certainly, grossly insufficient research.

Use of Animals in Experiments

In terms of the understanding and attitudes reputedly derived from the practice, the advantages and disadvantages of using animals for experiments in schools tend to be described as follows:

- | | |
|----------------------|--|
| Advantages | <ul style="list-style-type: none">(i) It provides an understanding of an important form of scientific work.(ii) It engenders balanced attitudes towards operating on, or with, a living body.(iii) It provides a quality of perception of the working of an animal which cannot be obtained in other ways.(iv) It can be used to develop caring attitudes with respect to limiting pain and discomfort. |
| Disadvantages | <ul style="list-style-type: none">(i) As an experiment in school it will not be original and it is not, therefore, needed scientifically; thus it leads to a false understanding of the ethics of research. |

*My conclusions about research have been helped considerably by surveys conducted by J.D. Wray and M.J. Barrowman. Details of the former's work are found in the publication of the Educational Use of Living Organisms (EULO) project. Mrs. Barrowman's work is reported in her Master's of Education (1977) thesis of the University of London.

- (ii) School pupils (and sometimes teachers) do not have adequate technical expertise to ensure an appropriate standard of performance.
- (iii) It reinforces attitudes of distaste and fear related to the functioning of a pupil's own body.
- (iv) It engenders nervous amusement rather than a serious attitude toward such experiments.

The results of research—for example with pupils taking the Nuffield Biology courses—are limited and ambivalent on the issue. Whether or not beneficial understanding and attitudes are developed by experimental work is not proven either way. What, however, appears to be clear is that an important influence is the level of commitment and control exerted by a teacher and, flowing from this, that there is a necessary set of preconditions needed to ensure the possibility of benefit. The students must approach the work seriously, there must be a serious and controlled context, e.g. small groups, and an adequate level of technical expertise demonstrated by those performing the experiment. In other words, the value of the work depends fundamentally on the preparation for the work and its context.

As has been mentioned previously, experiments with vertebrates in school are limited in Britain. Nevertheless, in part at least, much of what has been said can be applied to work with invertebrates and, I suggest it is ethically appropriate to do so. Given the broader view I believe there is a case, on educational as well as ethical grounds, for requiring appropriate training and possibly obligatory credentials for our teachers who wish to undertake this type of activity.

Necrology

For Britain at least it is probably true to say that there is far less danger of developing inadequate understanding and attitudes from experimental studies with live animals than there is from the use of dead specimens. One of the public reactions voiced against practical work in biology courses is over the number of organisms killed for educational use. The reaction is partly ethical—protesting against what is considered to be mass slaughter—partly on grounds of conservation. However, such views tend to be peripheral to the schools themselves. What is more influential in the schools is the kind of learning environment produced when practical work in a biology course predominantly involves dead material.

Again this has not been studied with any thoroughness but there is logic, if nothing else, in the view that this practice does little to enhance pupils' understanding of living phenomena nor develop their attitudes to live animals. A pupil once wrote of an instance of this necrological approach in this way—

*The bell rang for the end of break:
It was Biology next.
As soon as we came in he told us the bad news.
We were going to dissect rats.
As he opened the fridge the smell engulfed us.
He took out the rats, packed neatly in polythene bags,
And swimming in yellow preservative.
When we opened the bags the room smelt of biology.*

The use of dead specimens helps to develop some skills of observation and dissection. It possibly helps understanding of morphology and anatomy and provides some insights into functions. But it is debatable as to whether it does much more.

Most dead material is obtained by schools from commercial or local authority suppliers. In some schools, however, animals are killed, usually by the teachers or technicians, rarely by senior pupils. Again, this is possibly a peripheral influence on the attitudes of most pupils. In some schools, however, where killing is performed in an obvious and unconcerned way, it appears to lead to an atmosphere of oblivious disregard for the idea of living. Conversely, where killing is performed discreetly and, most importantly, in a concerned manner, a quite different and respectful atmosphere is engendered.

Alternative Methods

The main alternatives (other than plants or tissue cultures) to the use of animals in experiments and studies involving dead animals are three-fold; the use of illustrated texts, still and moving film, and models. What evidence there is suggests that in terms of factual knowledge gained and scientific principles understood these methods, if applied efficiently, are certainly not inferior. And that is about as much as we really know. Views on the extent to which such methods contribute to an understanding of the more holistic properties of living organisms and to the development of attitudes of concern for life vary and, no doubt, are influenced by the quality of teaching materials encountered and personal experience and predilections. It is a field in which, again, there is a need for much research.

More Valid Uses for Animals in Education

I have briefly surveyed the issues of using live animals for experiments and dead animals for scientific studies. They are clearly matters of current concern. We can conclude that there is uncertainty about their educational value and that there is an imperative need for research to elucidate the issues and for a fuller consideration of the educational use of living organisms in teacher education.

However, at the same time, I feel that these issues are a distraction from a more important concern: the need to study animals as part of human psychological and cultural experience. This would involve four educational objectives which are rarely considered at the moment: the cultivation of empathy; creating beneficial psychological relationships between people and organisms; developing an appreciation of the place of organisms in human culture; and establishing an alert consciousness concerning life and the environment.

Empathy

By empathy I refer to the understanding of an organism from that organism's point of view. Ideally this can be considered as entering the "mind" of the organism, which clearly is impossible. Practically it is manifested in the attempt to do this by interpreting one's human-biased knowledge of living things as relevantly as possible and being guided by attitudes of respect which ameliorate our anthropocentric tendencies and the recognition of each species' unique perceptual behaviour and ecological world. Empathy is something that requires continuous and close contact with organisms and involves using the full range of one's senses. It produces as much a sensuous as a cognitive portrayal of an organism and its milieu. At the same time it makes

it possible for a person not only to answer the question "What does an organism do?" but also, "What might an organism do under particular circumstances?" Both questions are important but the first requires a purely descriptive answer, the second requires one with a depth of understanding that anticipates the reactions of the organism. Possibly the best sense of this concept of empathy can be gained by reading the books of naturalists like Jean Henri Fabre and some of our contemporary ethologists—Tinbergen, Lorenz and Goodall, for example. Through their studies they have acquired a perspective of life—part knowledge, part feeling—that combines realism with respect. It is neither over-emotional nor cold-bloodedly scientific. It is a perspective that educationally is surely as worthy of a pupil's experience as others—those, for example, of the biochemist and physiologist based on physical studies of life—which tend to dominate today. Possibly it is one that gets nearer to acceptable truth than most.

The cultivation of empathy is also important for the understanding of ourselves and human relationships and it may well be of value to provide links between empathetic activities with other organisms and those involving fellow humans. The aim of these links would not be to provide a metaphorical imagery of people within other species. They would be concerned with defining each species' way of life so as to give greater reality to the qualities and limitations of our own.

Human-Organism Reactions

The use of organisms in the newer courses has not always been welcomed wholeheartedly. Reservations about dissection, the aversion of youngsters to some organisms (sometimes said to be "innate"), and the possibility of cruelty, neglect or wanton destruction by unsupervised children are among those voiced. In essence these are reservations about the ethical and aesthetic attitudes which pupils have, or may develop, toward organisms, and their relations with other living things in a very personal sense. Our knowledge of the psychology of these human-organism reactions is limited but one can see quite clearly their broader implications in, for example, discussions about significant environmental matters. With some people, the topic literally loses its significance or a silent subconscious barrier of abhorrence descends when the role of toads or snakes in a food web is mentioned: as long as it was elephants and geese that were being considered it had significance. They are sometimes the same folk—young or old—who are horrified if harm comes to a chick or hamster, yet do not move an eyelid when it is a wild partridge or a rabbit and will, with little compunction, squash a frog or leave tadpoles to suffocate in a jam-jar. There are similar ambivalent attitudes to different members of the human species and one wonders if, in fact, there are parallels here that might be more fully explored. To be aware of one's ambivalence of attitudes toward organisms is certainly salutary. It is educationally valuable to understand that human survival depends on our living in accord with other species and yet antagonistically with some, and that there is a need to seek a humane balance between rationality and emotion in our attitudes toward living things.

Human-organism reactions can also be of a more positive nature. Youngsters can benefit from the responsibilities and the satisfaction of purposeful activity derived from keeping animals. Children's affection for animals can satisfy certain of their psychological needs and afford a means of working out the developing appreciation of their personal and social roles away from the public scrutiny of their peers and adults. In this context animals become for children partial and understanding mirrors of themselves and the people they have to contend with. Given that this involves the development of sympathetic respect and does not involve aggression, it can be of immense

value.

Under this heading comes also the vexed issue of dissection. Should pupils see animals dissected? Should they undertake dissection themselves? For some, of course, dissection is required as part of their training as future biologists, nurses, doctors and the like. Even so, if it involves extensive killing, or brutality through neglect or callousness we surely must have reservations about saying yes to such questions. But is it sufficient to argue the case against dissection on grounds such that "children are squeamish" or that "dissection treats organisms with disrespect?" There are many people who have acquired attitudes of responsible respect for the bodies of organisms and their own; who treat accidents and operations with relative equanimity; who see beauty and fascination in the bodies of organisms; and who have a first-hand understanding of the workings of the bodies of living things of personal, practical value. They have acquired these qualities from studies involving dissection and acknowledge the benefits derived from them. Is there not an argument that pupils should not be deprived of this experience and of acquiring these qualities?

If we bear this in mind and link dissection with studies that portray the life of the same animals that are dissected . . . , If, as teachers, we practice those attitudes we wish to encourage and discuss with pupils the moral implications of dissection . . . , If we emphasize quality and enquiry in dissection and there is no question of forcing children to dissect . . . , If these conditions are fulfilled, might then dissection have a positive educational value? The point is that, apart from its use in training for specific occupations, the value of dissection, like that of other activities involving organisms (field work is another example), can only be judged in the fuller context of experience, feeling and morality; and in terms of creating beneficial psychological relationships between people and organisms.

Organisms and Human Culture

Many species are part of human culture. They play a role as objects to be studied. In this respect they feature in our scientific sub-culture and, in this context, they occur predominantly in education today. They are also physical and psychological components of our broader cultural environment. They provide food and materials. They can, through disease and predation, provide misery and destruction. Some domesticated species, have lost, or were never sought for, their utilitarian values but live with people as pets providing possessive, aesthetic and other satisfactions for them. Animals have for long been in human mythology (ancient and modern) and frequently are cited in metaphors. They are a part of a great deal of our normal behaviour from zoos and international horse trials, as the focal point of so much of rural life, in nature conservation, in science, sport, in art, with implications that reach out into religion, law and government. In philosophy, organisms feature in discussions of man's place in the natural world, be it in terms of, for example, his dominion over nature—seen particularly in Marxism; as part of the evolution of life—ideas that stem from Darwin; or, as those such as Albert Schweitzer and Teilhard de Chardin would conceive it, in terms of a mystical kinship between man and the natural world: a notion expressed years before by Alexander Pope in his *Essay on Man*:

*All are but parts of one stupendous whole,
Whose body Nature is, and God the soul;*

To have an appreciation of the place of organisms in human culture is surely of educational value. It is part of getting to know ourselves, and of acquiring a further perspective of life which, in individual and social terms, will allow us to appraise the significance of what we do to ourselves and to our environment.

Life and Environmental Consciousness

Behind these ideas of the role of empathy in understanding organisms, of the importance of stimulating an awareness of the balance of rationality, emotion and values which prescribe our attitudes toward living things, and of the recognition of the part played by other species in human culture lies an implicit, central inference: that for people today it is imperative that they be continually conscious of the concepts of life and of the natural environment. This does not just mean that they should know about living processes or ecology in the same way as they may know a mathematical formula, the history of the Roman invasion of Britain, or the action of enzymes on foods. They need to be aware of the concepts sufficiently that they rise automatically and immediately in a person's consciousness whenever relevant issues occur. The concepts should be understood sufficiently that they can be applied with appropriate selection and due consideration for the limits of knowledge. We are concerned with a level of consciousness where knowledge is intimately linked with motivation, feeling and activity and possesses a moral dimension involving not only scientific neutrality but also the antagonisms of good and bad, and beauty and ugliness.

The reason why this is necessary is simple. We are living phenomena and we depend on our natural environment. The influences of biological alienation present in the urban environment, in the deprivations of some of the underprivileged and in the sophisticated social and intellectual life of some of the privileged, make this dictum a particularly necessary caution. We need to be aware continually of the implications of our nature.

Courses and Resources

If the propositions I have outlined are valid it follows that the methods by which we study life in schools may well require revision. Three questions can act as the framework for reviewing what is needed.

- 1) How relevant are our present biological courses?
- 2) What significance do the propositions have for areas of the curriculum other than biology?
- 3) What type of facilities are required?

The emphasis of biology courses has moved from anatomy and physiology to one which gives more equal weightings to genetics, ecology and other areas of the subject. This provides a fuller portrayal of the living processes but tends to fall short on two counts. The dynamics of the life of organisms tend to be underemphasised and, because usually a purely analytical approach is employed, the parts of organisms and, to some extent, ecological systems tend to be emphasised rather than the synthetic whole which is the essence of any living being or system. To provide the fuller perspective that the propositions suggest will require the whole organism to be the focus of activity with greater emphasis on its ecology, behaviour, development and reproduction. It will require also that exercises in synthesis, not just analysis, be employed. Students could be asked to design and possibly build a pond or some other ecological sys-

tem, not just to study its components. They could be involved more extensively than at present in studies focused on the interrelations between the parts of organisms and those between organisms and the environment. They should be encouraged to think about and develop empathy toward living things through studies of behavior and ecology based on intensive observations of a limited number of species.

Room will be needed also for topics dealing with the role of organisms in human culture and for students to engage in activities dealing with issues related to them. They might, for example, consider what fish mean to people and deal with the fishing industry, fishing for leisure, the aquarists, fish in our folk tales, the symbolism of fish in religion, the fisherman's and the zoologist's knowledge of fish and so on. They would, no doubt, soon come to realise that fish have much greater significance in human culture than being the associate of chips in the Englishman's diet. In the same way as words such as "application" and "conservation" have gradually acquired sufficient respectability to be included in syllabuses so might "mythology", "ethics," "economics," "legal" and others that reflect the range of human implications flowing from the study of living things. It will have to be accepted also that there is educational value in tackling the more obvious social problems such as those about agricultural production and at the same time discussing deceptively simple, more philosophical questions such as "What is a weed?", "What sort of world does a rabbit perceive?" or "Is the survival of the fittest good?"

The study of organisms in this context spills over boundaries of biology into many other subjects. It can be included in historical and social studies. Art can contribute to our aesthetic appreciation of the living world. Understanding an organism's way of life can be played out in role-playing, the drama of environmental issues in theatrical productions. Beyond the normal subject limitations pupils could engage in studies in which "life" or "organisms" serve as a central theme for coordinated activities cutting right across the curriculum. Activities which are now relegated to an extra-curricular place—pet keeping, gardening and conservation in the school or local environment, for example—could be utilised as for foci for more extensive study within the curriculum.

To meet demands such as these requires much from the school curriculum. It first has to be acknowledged that it implies a considerable time allocation. If we are to include the range of study of organisms as outlined here and, at the same time, include also human and social biology (including topics such as health and sex education) and aspects of environmental study which are equally important, and still include some of the values of classical biology, more time will be needed. It is possible to conceive of a new form of biology course in schools but more important it is to be hoped that a more receptive and flexible attitude will permit a *variety* of courses so that for different ages the study of life has different emphases and that cooperation between subjects will add to this variety.

Allied to this is the need for flexible timetabling and for what might be called "biological deschooling." The forty to eighty minute blocks so typical of secondary school timetables but becoming rare in the primary schools are, no doubt, appropriate for some subjects such as language and mathematics. You can fit into them the type of science (not usually scientific) experiments which demonstrate well-regulated phenomena (usually not physical or chemical). But for activities concerned with the local environment, with observations of organisms or habitats which are changing or difficult to predict, with visits to field study centres, zoological and botanical gardens and the like, or with those activities, such as conservation work or the care of plants and ani-

mals which require regular commitments from pupils, there is the need to be able to exchange or combine time between subjects and to have more extensive time allocations for interdisciplinary studies and activities out of the school. Many of these activities are relegated to the position of extracurricular activities. What is needed is the removal of the distinction between timetabled and extracurricular work and the opening up of the timetable to include a much greater variety of endeavours.

The study of life will also need to be conceived as more than just biological science. Although it is important that science has a central role, greatest value will come from accepting life studies as a field of interest served by many disciplines and involving a wide range of activities. It will have to be granted a comprehensive status, suitable for all pupils and uninfluenced by attitudes which set up the dichotomy prescribing nature study and topics to do with human beings and society for the young child and the less able older pupil, and restricting biological science to the more able.

To provide the facilities for life studies of the sort described will require an economic attitude which sees it as worthwhile to spend money on a room or part of one which contains suitable habitat enclosures and containers in which a variety of organisms live in simulated natural environments, well serviced and with arrangements for the safety of both pupils and organisms, as it is to line the walls of the room with cupboards and apparatus. Given this attitude it is possible that, in a relative sense, the costs need not be excessive for what is envisaged is that instead of having a laboratory, greenhouse and animal house isolated from one another they should be built into an integrated area for Life Study which would contain also the equipment and other materials needed for the variety of activities that have been mentioned earlier. Instead of the greenhouse and animal house being isolated and used merely for maintaining and breeding stocks of plants and animals, equivalent facilities should be available where the pupils normally work. This would give the opportunity to study the lives of the organisms in, as near as can be obtained, their natural setting. Aquaria are obvious and well-known examples of simulated habitats. Terrestrial vivaria serve the purpose equally well and, with the equipment now available for regulating temperature and humidity, a range of habitats from tundra to tropical could be constructed. Multiple habitats, e.g. aquatic-terrestrial-aerial, could also be demonstrated. Others might include open-sided burrows for gerbils and hamsters or colony chambers for mice.

Ideally this internal Life Study Area would also have easy access to one outside, not necessarily large and either urban or rural in character. This could be a natural habitat or a garden that can be used for investigating a range of associations between organisms. If provision was small it could be merely the microenvironments of paving stones and guttering in the school grounds. From this area would commence a series of well-mapped, although not necessarily easily identifiable, "nature" trails providing the guidelines for local studies. Such facilities might be shared by a number of schools.

In addition, one would hope that parallel with the development of such facilities as these in schools, the developments in recent years of field study centers of Local Education Authorities (LEA) and national bodies and the educational work of national parks, zoos and botanical gardens would continue and be more fully integrated into the educational process. They can do much, and in some respects more than the schools.

Overall such a range of facilities would allow for a balance between planned and casual activities to meet the variety of requirements of students stretching from those intent on scientific studies to those needing the emotional satisfactions of being with plants or animals and, at the same time, provide the means of achieving the objectives

of life studies we have considered. Of course, the objectives can be criticized as being too demanding on the resources of teachers and schools. But, if one looks back on what has been achieved over the last decade or so, and at the same time, recognizes that most of the ideas have already, in fact, been implemented to some extent in some schools such apprehensions can be queried. Like so much in education the real question is "Is it worthwhile?" The answer lies in the acceptance, or otherwise, of a simple proposition: to understand life, other than in an immediate and purely social sense, a person has to encounter the living world, question their relation to it, appreciate the uniqueness of each species, including their own, within it, and to perceive other species as part of the human environment, both physical and cultural. Is this to be the framework of life studies or do we retain the ornamental rabbits and geraniums and our memories of when "the room smelt of biology?"

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The Vertebrate Animal in High School Biology

Alan M. Beck

Abstract

Live vertebrates afford opportunities to capture student interest and develop important educational experiences. Humane care and handling of the animals can be one of the most significant aspects of the lesson.

The study of classroom animals could include a wide range of observational and experimental protocols that do not compromise humane or conservational standards while providing background on the basics of science that encourage and prepare the student for continued education. Basic attention to detail and careful supervision will insure humane care of the animals and minimize the possibility of injury to students from bites and infection or discomfort from allergic reaction. As a general rule, only animals that can be humanely maintained and safely handled by the students should be permitted in the classroom. The animal's total existence, from source to ultimate disposition, is the ethical concern of everyone involved.

Field and zoo studies provide the opportunity to teach behavioral, morphological, ecological and evolutionary principles in ways that do not necessarily duplicate the material in textbooks but can reinforce the material while encouraging more reading and thoughtful reflection.

Part of any educational curriculum is the development of informed and healthy individuals whose moral values correspond to those of the society at large. Our society does value respect for life and therefore including the humane concerns for animals is rightfully very much part of any educational program.

Introduction

The Value of Live Vertebrates in Education

I have always felt that those who taught sex education and biology had an advantage over all other teachers for they could more easily capture the attention, and hold the interests, of their students. Sex educators could allude to the material that comes after binary fission and pollination and biologists could always utilize live animals. It seems almost all animals are of interest to young people, but vertebrates, perhaps because we are among them, hold the most fascination. Vertebrates are more than interesting, they are appealing. But users of live animals have a special responsibility; the care and fate of an animal becomes part of the lesson and very much influences the information and attitudes the student takes from it. Researchers and teachers in the biomedical and behavioral sciences must constantly be sensitive to the needs and atti-

tudes of the society served and animal care and use programs should be conducted in ways beyond reproach (Clark, 1979). Our society today takes a dim view of a callous attitude which treats animals as merely research tools, similar to glassware, microscopes or computers (Clark, 1979).

This very conference is testimony of the fact that our society is rapidly approaching a time when the care of animals is believed to be the ethical concern of all people involved in their handling.

In a more pragmatic vein, few people deny the fact that our treatment of animals is often reflected in our treatment of each other. Therefore, a wholesome treatment of vertebrates will directly benefit people by raising the humane consciousness of the students for all life.

Classroom Studies

Responsible Custodianship

Responsible custodianship involves the care, shelter, population control and disposition of all classroom animals. The users of animals should be familiar with and have ready access to any of the guides for animal facilities and care, such as those prepared by the Department of Health Education and Welfare (HEW), American Association for Laboratory Animal Science (AALAS), the Institute for Laboratory Animal Resources (ILAR), the Universities Federation for Animal Welfare (UFAW) or the American College of Laboratory Animal Medicine (ACLAM). The teacher's own knowledge, resources and the quality of the classroom's facilities should determine the kinds and numbers of animals maintained. Teachers should have firm budgetary commitments, to handle food and veterinary emergencies, before the animals are ever brought into the classroom. The teacher should try to anticipate all problems and have solutions ready. Such problems may include feeding and climate control during weekends and vacations, and classroom security.

Noninterventional Studies

It is not my intention here to outline a specific experiment for there are many books and manuals that address this aspect in great detail; e.g., The Animal Welfare Institute's (1960) *Humane Biology Projects*, and Price and Stokes' (1975) *Animal Behavior in Laboratory and Field*. It should be noted, however, that many manuals are not as sensitive as they should be regarding the handling of animals and often are deficient regarding the subsequent disposal of the animals after their use. At this time, I would like to raise areas of study that could be best addressed using small numbers of animals that could be maintained indefinitely or subsequently disseminated as pets.

Observational and behavioral studies afford an appropriate use of animals. Teachers of behavior should be familiar with some of the basic guidelines for conducting observational studies; e.g., Altman's (1974) review in *Behaviour* of sampling methods and Lehner's (1979) new book on ethological methods are excellent guides for the teacher though probably too technical for routine high school reading.

Noninterventional studies could address a variety of aspects that could serve as an introduction to broader questions, e.g. the comparisons of social and solitary behavior. Gerbils and hamsters, respectively could be used. These animals could be bred in a limited fashion for studies of reproduction, development, maternal care and learning. Inbred strains of mice with differing behaviors are available for studies in the fascinating field of behavioral genetics.

Fish lend themselves to captivity, and are available in a variety of species that demonstrate a wide range of morphological and behavioral adaptations.

Interventional Studies

Basic questions about learning, conditioning and preferences can be addressed by humane manipulation. For instance, the laboratory rat is quite comfortable in captivity, and experiments with mazes can be designed to challenge the student's ability to test hypotheses while catering to the animal's natural tendency to explore and exercise. In learning experiments, positive reinforcement as opposed to punishment, should always be the protocol. Reward is more humane and effective.

Teachers should consider utilizing pets brought to the classroom for specific projects, therefore reducing the number of animals purchased for educational purposes. I always wanted to repeat some of the classical experiments demonstrating how dogs can distinguish the odors of different people including identical twins. Such a study would demonstrate that animals are not as "dumb" as they appear which would foster a greater respect for them. In addition, such an experiment would introduce the variety of ways vertebrates solve problems, and this too would encourage a greater respect for all life.

Classroom Safety

Only animals that can be safely handled by students should be permitted in the classroom; in this way even student mistakes or animal escapes pose no special problem. A record of each animal's source should be maintained in case it is ever necessary to know the animal's background. As an example certain groups of hamsters may be involved in an outbreak of lymphocytic choriomeningitis or a batch of birds may have been associated with a reported occurrence of psittacosis-ornithosis. Teachers should show great discretion in taking in wild animals; orphan skunks may be rabid and birds might have mites.

Teachers should take some general precautions to protect students from bites, infections and allergic reactions. The possibility of a bite exists with almost any vertebrate, however, the risks can be minimized. Obviously, every science room should be equipped with a first-aid kit and a protocol for treating and reporting bites. Every student that will handle any animal should receive careful and individual instruction on proper handling. Gloves can be used for new and unreliable animals. Cages should be in good repair and free of any sharp protrusions that can cut or scratch animals or people. Also, the cage-meshing should be close enough to prevent people from idly sticking their fingers into the cage.

Infections can be minimized by keeping cages clean with little accumulation of waste. Students with open wounds, cuts or irritations should not handle animals except with gloves. All personnel should wash their hands after handling animals or cages and before eating. This is especially true after handling turtles and birds because of the possibility of a salmonella infection. All sick animals should be isolated and veterinary services should be sought.

The teacher should be sensitive to the possibility of allergies and phobias, and tactfully exempt any student on request. If any student complains of sneezing, coughing or itching they should be instructed to refrain from future handling of animals.

The article: Classroom ecology and safety (Gordon et al., 1972) in the March, 1972 issue of the *Journal of School Health* is a good general outline of safety problems.

Field Studies

Field studies afford the opportunity for students to appreciate a wider variety of animals without the financial and humane concerns of captivity. In fact, one of the best introductions to biology is through natural history, for it imparts to the student an appreciation of the interactions and complexities of the natural world (Dice, 1960). To be sure, it is more difficult than the basic sciences approach for the teacher is required to have a broader range of information. Often this information is less conveniently available since localities vary. However, there are manuals and field guides, as well as local museums and residents in an area that can be of great help. There is even an office of the National Audubon Society in midtown Manhattan. In every community there are large populations of fish, birds and mammals available for study, e.g. carp, pigeons, sparrows, squirrels, rats and dogs. The readily available populations can be utilized to teach the concepts associated with activity cycles, home range, food finding, shelter, courtship, social interaction, utilization of resources, flight distance and genetic variability.

Birds are readily visible animals and often their whole life cycle can be observed. Nesting habits are not all that well known, e.g. what males do at night, so biology classes could generate new and, perhaps, publishable data which would raise the self-esteem of the student and bring home the importance of science (Dice, 1960). Shore birds, which are readily observable, demonstrate a wide variety of adaptations to the environment relating to feeding, courtship and social interaction.

There is already literature available on cats (Laundre, 1977) and dogs (Beck, 1971, 1973, 1975a; Fox, 1972, 1975, Fox *et al.*, 1975; Nesbitt, 1975) that can be used to provide a basis for comparative observations and encourage the student to formulate new questions. I would like to propose the dog as a subject particularly suited for field observation as they are readily available, often diurnal, individually recognizable and tolerant of human proximity (Beck, 1975b). Students should be versed on how to avoid being bitten (Beck, 1976).

There are several approaches to dog studies. One is the study of specific individuals. Strays or a loose pet could be followed while building a behavioral profile, including activity patterns, scent marking, home range, and social behaviors. Another approach could be to study the animals that are in a specific area or locale.

One variation in a naturalistic study is to use a "feeding table", e.g., animals are attracted by the consistent deposit of food. While this is an intervention into the natural setting, it is not necessarily disruptive for even in nature there are naturally occurring accumulations of a resource. Feeding tables for squirrels, birds, cats or dogs would permit students to view interactions more efficiently by making the animals' appearance more predictable. Look for natural "feeding tables" such as dumps and landfills as these are often rewarding sites for study.

Zoo Studies

Zoos permit the teacher to utilize a wide variety of species in the study of behavior, evolution, anatomy, and taxonomy. Example, what similarities can be observed among animals in similar environments? What is the repertoire of behaviors that can be observed among the felids and canids? Amphibians and reptiles are often part of the collection of even smaller zoos and students can be challenged to look for adaptations of form, color, color patterns and behavior. Perhaps the students might want to classify the snakes first by morphology (size, color and color pattern) and then by habi-

tat and then taxonomically. Discuss the subsequent differences of classification. Such exercises challenge the student's natural curiosity and help develop the ability to reason logically. Hediger's (1969) book, *Man and Animal in the Zoo*, provides a good background on the nature and problems of zoos for both the student and teacher.

Photography

The role of photography in all aspects should be explored where possible. Photography could be used in the teaching of recording data as well as developing an esthetic appreciation of animals. Perhaps, future generations can use cameras as a means of experiencing the contact with nature that is now sometimes expressed by hunters with guns. Photography should not be used in lieu of good observation and photographic exercises should pay attention to the whole environment.

Human Studies

Humans are a vertebrate worthy of study, however, remember to respect the dignity and privacy of any subjects. Basic observations in cafeterias, parks or playgrounds can give great insight into spacing, grouping and general behavior (Barash, 1973, 1975; Cohen, 1971; Beck and Marden, 1977). Even automobiles afford opportunities to study human interactions (Dobb and Gross, 1968).

The teachers should remember when working in the urban environment to respect local residents, avoid private property and be careful not to frighten people unfamiliar with the goals of the study.

Conclusion

In the past, high school biology has relied on the use of animals in ways that often reflected a callous disregard for the animals' inherent self-worth as living creatures; examples include the preserved specimen, pithed frog, museum-type collection of captured animals or poorly maintained class "pets" that were merely objects of curiosity. We may never know how this callous attitude encouraged a disregard for life that may have even included our own kind.

I propose that all the fundamental basics of science that are the proper concerns of those with a secondary school education could be better taught by including a total commitment for animal welfare. In this way, not only will the basic materials be explained and demonstrated but students will be more attentive and interested in learning. The knowledge to be gained by appreciating a living creature in the class, field or zoo, can reinforce the technical material found in the texts and may very well encourage further inquiry. In addition, the lessons would incorporate patterns of behavior and social attitudes that the student will use to be a better person and more acceptable member of our society.

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Animals in British Schools: Legal and Practical Problems

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Abstract

Well-managed, healthy animals can be useful and beneficial aids to the emotional and intellectual development of young people at the primary and secondary levels of education. In Britain, vertebrate animals are not used in schools for experiments which might cause pain, distress or disease. The laws protecting animals are comprehensive but at present it is the Health and Safety at Work Act (1974) which is having the most impact on the keeping of animals in British schools. The practical skills most needed by teachers are in the handling, sexing and humane killing of animals. Training of teachers should include instruction in these, as well as in the care and management of laboratory species.

Introduction

The policy of the Universities Federation for Animal Welfare (UFAW) toward keeping animals in schools is that if it can be done well, so that pupils learn sound management principles and caring attitudes, then animals are a beneficial aid to their emotional and intellectual development. If it cannot be done well, it should not be done at all. We are in agreement with the Schools Council policy as laid down in their Recommended Practices for Schools relating to the use of living organisms and material of living origin (Wray, 1974).

In the early 1970's a working party was set up by the Royal Society and the Institute of Biology to discuss whether dissection of dead animals was really necessary in schools. Their answer was a qualified 'Yes' for pupils of 16 years and upwards (Report, 1975). If a similar group were set up to discuss whether experiments on live vertebrates involving pain, distress or disease were necessary to achieve British educational objectives, the answer would almost certainly be an unqualified 'No'.

Legislation

The legal situation in the United Kingdom is that experiments on vertebrates likely to cause pain, distress or disease are forbidden, unless the premises are registered by the Home Office and the experimenter holds a license under the Cruelty to Animals Act of 1876. No schools are on the list of registered premises and this means that no experiments involving surgery or requiring anaesthesia are being carried out there on ver-

tebrates. Nonmammalian vertebrates are less closely protected than mammals. For example, an unlicensed person may pith a frog: the frog is then legally dead and can be used for experiments. Chick embryos may be used up to the time that they are viable (about 19 days). Nonsurgical experiments are permitted so long as they are not liable to cause pain, distress or disease. For example, behavioural experiments involving open fields, mazes or Skinner boxes are permissible so long as the animal is not starved beforehand and no aversive stimuli are used. Killing an animal does not constitute an experiment unless the method is untired.

The Protection of Animals Act (1911, England and Wales; 1912, Scotland) is the most comprehensive law protecting animals in Britain. It is an offence under this Act to cause pain or distress to a domestic or captive animal. Offences include omitting to provide food and water; performing operations such as cutting claws without due care; and poisoning, which would include the injection of toxic substances. One purpose of the 1876 Act is to permit bona fide scientists to perform procedures which would be offences under the 1911 Act. An unlicensed scientist such as a biology teacher could be liable to prosecution under both Acts. For instance a teacher feeding a rat on a diet deficient in Vitamin B so that the animal grew up with a deficiency disease would be infringing the 1876 Act if he fed the diet intentionally but he would be infringing the 1911 Act if he did it by mistake.

The Dangerous Wild Animals Act, 1977 makes it illegal to keep captive any dangerous animal such as a wolf, baboon, crocodile or lion without a licence from Department of Environmental Health. This is primarily to protect the public, but the Officer will ensure that the method of caging is humane before issuing the license. This Act should not have practical significance to keeping animals in schools since dangerous species cannot be recommended as educational aids.

The Protection of Birds Act, 1954 makes it illegal to trap or keep in cages any British birds except those classified as pests, such as pigeons or crows, or game birds. Consequently, the birds kept in British schools are those bred in captivity such as canaries and budgerigars.

The Health and Safety at Work Act, 1974 is the law having the most impact on keeping animals in schools at present; it is not concerned with the protection of animals but with the protection of employees. Animals can be dangerous (Wray, 1975). They bite and scratch; they transmit diseases; they escape and chew the electric wiring. Before 1974 an injured teacher or pupil could bring a civil action against the school and claim compensation. Now, if there is an accident and the Health and Safety Inspectors consider that it was caused by the negligence of the employer, then the Educational Authority is liable to criminal action and a heavy fine. This has made many head teachers nervous and inclined to use the present financial cut-backs as an excuse for reducing the number of animals kept in the school. In the long run this Act will benefit animals by forcing schools to consider more carefully what allocations of space, money and staff are required to maintain a well-run and therefore safe animal unit.

Safety Considerations

Animal supply is an example of the necessity for planning. Some Education Authorities hold animal banks for supplying the schools in the area, but if they do not and if the teacher's budget is too low, the temptation to go to the pet shop around the corner for his animals may be overwhelming. To ensure safety, animals should be ordered from accredited breeders who can guarantee that their animals are free from zoonotic diseases such as tuberculosis, pasteurellosis, scabies, ringworm, salmonellosis, leptospirosis and lymphocytic choriomeningitis. This last mentioned disease, LCM, is commoner than realised. A recent survey in Britain showed that 5% school children carry antibodies to LCM. The symptoms are similar to those of influenza: fever, headache and muscle pains. The danger of the disease is that it sometimes passes on to a second phase involving meningitis, and if contracted during pregnancy it can cause eye defects in the fetus. The virus is thought to have its reservoir in wild rodents and to be transmitted from them to pet rodents such as pet mice and hamsters. The route of infection to man is thought to be the contamination of broken skin by infected saliva and urine and probably also by the inhalation of infective particles (Skinner and Knight, 1979).

The presence of zoonotic disease in wild rodents makes it important to rodent-proof any room where animals are kept in schools. Holes in floors and walls must be blocked, drains specially designed and heating and ventilation ducts proofed. Animal rooms and food store rooms act like magnets to wild rodents; the problem of keeping them out will often be greater than the problem of keeping the inmates in.

Practical Considerations

The safety considerations are important but to the teacher they may appear secondary to the practical problems of handling and sexing animals, particularly mammals, and their routine management. Handling and sexing are not easily taught from a text-book. A modicum of skill is required which can only be acquired by practicing on live animals. Some sort of instruction should be provided to teachers at either the student-teacher or in-service level.

Information on how to feed and care for animals can be obtained largely from books, for instance those produced by UFAW (undated, 1976, 1978) and the Schools Council (Wray, 1974; Wray and Gaitens, 1974). A course of instruction could be used to emphasize those points which are not immediately obvious. Examples are the necessity to buy sterilized bedding materials because of the risk of wild rodent contamination in sawmills; the need to supplement the diets of guinea-pigs if they are being fed standard rodent pelleted diets because of their special requirement for vitamin C; the concept that the regular removal of soiled litter is not so much a chore as an exercise in preventive medicine because the ammonia released from the breakdown of urine in litter is actually harmful to the respiratory mucosa of the animals. The role of the human hand in the transmission of disease becomes clear once it is demonstrated how bacteria in the undressed cut on the hand of a student may be transmitted to broken skin on the animal during handling; how pathogens may be transmitted from one to the next during handling; and how pathogens such as *Salmonellae* from a mouse or a tortoise will eventually pass from the hand to the mouth of the student.

Disease-free animals can also be a health hazard to humans. Some teachers claim that at least one pupil in every class will develop an allergy to animal hair, urine pro-

tein dispersed in dust, or to locust dust. The allergy may be seen as a reddening of the skin after contact or as running eyes and nose after inhalation of dust. The best treatment is to avoid contact, but if this is impossible, as in the case of the teachers themselves, then the symptoms can be controlled medically.

Euthanasia

Euthanasia is a subject repugnant to many people, and even some teachers, when faced with the problem of disposing of their old, sick or vicious animals, may try to pass them on another school. This is obviously unsatisfactory at the secondary school level. For euthanasia of small animals, UFAW (1978) recommends carbon dioxide. Special apparatus can be constructed to use either solid or gaseous CO₂ or the animal can be dropped into a plastic bag inflated from a CO₂ cylinder. These methods are suitable for mice, rats, guinea-pigs and hamsters. It is particularly useful for vicious animals which cannot be removed from their cage: the cage can be placed in a plastic bag at least 5 times the volume of the cage and CO₂ run in from a cylinder. Chloroform is still widely used for killing animals. It is humane but rather toxic to the operator and highly toxic to other rodents. In some strains of mice, exposure to low concentrations of chloroform will render the males infertile. Rabbits react badly to chloroform; they are too large for pure CO₂ to be considered humane; mixtures of CO₂ and oxygen which are humane require sophisticated equipment to ensure the right proportions; the kindest methods to kill rabbits are either for an experienced operator to break its neck or for a veterinary surgeon to give an injection of barbiturates. These methods are described in *Humane Killing of Animals* (UFAW, 1978).

Summary

The new syllabuses introduced into British schools in the 1970s have stressed the importance of living animals in the classroom. This has led to a need for information, guidance and advice on how to keep animals in schools, particularly where this was not included in the curriculum of student teachers. At UFAW, we have tried to contribute to this supply of information with the hope of improving the welfare of the animals in schools and of increasing the satisfaction and pleasure of the people responsible for their care.

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No Pain Infliction by Untrained Youths

Christine Stevens

Abstract

Outlined are the efforts of the Animal Welfare Institute (AWI) for the last twenty-five years to end abuses to animals in high school biology programs. After concluding that the AWI's two brief rules prohibiting painful experimentation were not well understood by students even after years of effort, the AWI adopted the rules of the Canadian science fairs, which are similar to the Westinghouse Talent Search in that they simply prohibit experimentation on vertebrate animals. The presentation includes reference to the AWI manual, "Humane Biology Projects."

Development of Scientific Thinking and Observation

Close observation of animals by scientists of genius have contributed enormously to the changing view of the relationship of our species to the others. We are beginning to wonder whether our capability to do massive harm may be the major distinction between man and what used to be commonly known as "the brutes."

Henri Fabre, Charles Darwin, Karl Von Frisch, Konrad Lorenz, Niko Tinbergen, Jane Goodall, George Schaller, Iain Douglas-Hamilton, Dian Fossey, to name a few inspired field naturalists, have changed our concepts, while the Gardners, Roger Fouts, and Francine Patterson, who have pioneered in communications with the great apes, have shown us what is possible through painstaking research in understanding the thinking of some of our fellow inhabitants of the earth. Rachel Carson (1977) wrote:

I like to define biology as the history of the earth and all its life—past, present, and future. To understand biology is to understand that all life is linked to the earth from which it came; it is to understand the stream of life, flowing out of the dim past into the uncertain future, is in reality a unified force, though composed of an infinite number and variety of separate lives. The essence of life is lived in freedom. Any concept of biology is not only sterile and profitless, it is distorted and untrue if it puts its primary focus on unnatural conditions rather than on those vast forces not of man's making, that shape and channel the nature and direction of life.

To the extent that it is ever necessary to put certain questions to nature by placing unnatural restraints upon living creatures or by subjecting them to unnatural conditions or to changes in their bodily structure, this is a task for the mature scientist. It is essential that the beginning student should first become

acquainted with the true meaning of his subject through observing the lives of creatures in their true relation to each other and to their environment. To begin by asking him to observe artificial conditions is to create in his mind distorted conceptions and to thwart the development of his natural emotional response to the mysteries of the life stream of which he is a part. Only as a child's awareness and reverence for the wholeness of life are developed can his humanity to his own kind reach its full development.

These words appear in the preface of *Humane Biology Projects* (Animal Welfare Institute, 1977). In the body of this publication are numerous examples of projects and teaching suggestions which encourage development of scientific thinking and rigorous observation, always respecting the feelings of animals if they are involved. This manual has been through numerous printings and one revision since it first appeared in 1960 and has been welcomed consistently and increasingly by teachers. There can be no doubt that attitudes have changed in that period from an attempt to have children imitate animal experimenters in a superficial manner to the present serious attempt to teach principles of ecology and to encourage young people to analyze and understand the environment as a whole.

Development of Research Capabilities in Schools

Callousness and cruelty toward animals seems to be an expectation of the naive mind in laboratory studies involving animals. It would appear that a higher proportion of children's experiments inflict suffering on animals than experiments by qualified scientists publishing in established journals. The children's experiments provide no cures for diseases or other useful advances; they simply cause pain and distress and set young minds off with a basic misconception of the meaning of research, a head start in insensitivity and an assumption that the strong may, with impunity, impose suffering and death on the weak.

An interesting comparison of projects from California (all humane) and from other states (often inhumane) was prepared by Dr. F. Barbara Orlans (1978) when the International Science and Engineering Fair was held in California, a state which prohibits painful experiments by untrained youths. The success of the California law in halting cruelty shows how valuable this state statute is. Massachusetts passed a similar law in 1979. The attempt to repeal an existing Illinois law prohibiting animal experiments by high school students has thus far failed.

It is our experience that it is necessary to be specific in standards or regulations on this subject, whether they be in the form of law or of voluntary agreements, as in the case of the rules for Canadian science fairs. The Animal Welfare Institute (AWI) has worked to end cruel experiments by untrained youths for more than twenty years. We began by distributing two brief rules. Large numbers were requested by teachers, and their wide distribution by mail and at science teachers' conventions doubtless did some good. However, my confidence in their effect was considerably shaken when I saw them prominently displayed at a local science fair in front of an animal experiment which plainly violated them. Dr. Harry Rowsell had similar difficulties in making plain English understood. (See Rowsell, "High School Science Fairs . . . The Canadian Experience.")

The Westinghouse Science Talent Search was the first to recognize that the most effective way to prevent untrained young people from undertaking projects wholly

unsuitable, because of the infliction of severe pain on animals, was to limit animal studies to pure observation of wildlife or domestic animals.

It was after a horrific project in which a young girl blinded sparrows and starved them to death that Westinghouse examined this and other projects undertaken because a young student aspired to win a prize. The company made the wise decision to prevent any cruel projects in the future.

Since Westinghouse made its rules crystal clear, no cruel experiments have been conducted by young people seeking to win these distinguished prizes. Because of the California law, no cruel experiments by California students were shown at the International Science and Engineering Fair when it was held in Orange County in 1978. The Canadian science fair rules, initiated through the leadership of Dr. Harry Rowsell, have been successful in heading off pain infliction on animals by untrained youths. The AWI has adopted these Canadian rules because the evidence shows them to be the best. They appear in the introductory pages of *Humane Biology Projects* (Animal Welfare Institute, 1977). We recommend their adoption by all teachers and others associated with science fairs.

In making this recommendation, I want to emphasize that there is nothing anti-scientific about it. The great biological discoveries of the future may well depend on a major increase in our understanding of other life forms and the feats of which they are capable. By encouraging development of sharp observation among future research workers, we encourage this capability. Such capabilities are no less desirable in the laboratory than in the field. Respect for rigorous standards in the acquisition of knowledge is more readily acquired when crude surgical or other invasive animal experiments are not allowed to create an illusion of scientific reality for lazy minds.

The importance of developing the ability to observe animals behaving naturally was startlingly documented in a recent article, "Dr. Guthrie and *Felis domesticus* or: tripping over the cat" (Moore and Stuttard, 1979). The authors showed that completely erroneous conclusions had been reached over a period of years because it had not occurred to scientists who were using operant conditioning techniques to consider that their feline subjects might be greeting them as they entered the room. Moore and Stuttard (1979) wrote:

When Guthrie and Horton set out to study the stereotypy of learned behavior, they chose to observe at close range the reactions of individual animals while rewarding them for contact with the vertical sensor rod. In retrospect, their methods were self-defeating. (i) They failed to consider the animals' species-typical repertoires. (ii) Both experimenters and as many as eight guests sat in front of the glass-fronted chamber, unconcealed by any blind. (iii) Each trial began with the animal's reintroduction into this setting, making "greetings" especially probable. (iv) The vertical rod, intended as a natural response sensor, provided an almost ideal target for redirected rubbing. Thus, efficiently if inadvertently, the experimenters arranged to evoke the species-typical reactions which they, and many others, failed to recognize and which were construed as evidence for particular learning mechanisms.

This interesting paper underlines the importance of a more friendly approach toward animals rather than holding them, as it were, at arm's length, referring to them by number rather than by name or by some other individualized method. In other words, true science should move toward becoming truly humane.

We have the opportunity in the training of young future scientists to encourage them in paths of sympathy and consideration for fellow animals. We should avoid developing a harsh and unfeeling attitude, both for the benefit of animals and for the benefit of the young people and their intellectual and emotional development.

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SESSION III

High School Science Fairs: Evaluation Of Live Animal Experimentation

CHAIRMAN: ANDREW N. ROWAN



Science Youth Activities and Animal Experimentation

E.G. Sherburne, Jr.

Abstract

Science youth activities (extracurricular science activities) involve millions of young people at the elementary and secondary school level. Such activities are popular with young people and with teachers because they offer values different from those provided by classroom work and the required laboratory. National science youth activity programs include science fairs and the International Science and Engineering Fair, the Science Talent Search, and a number of other programs. For activities involving research, animals have been increasingly used because of the increased sophistication of the students doing the work. While some projects using vertebrates may be done poorly, it is suggested that these are a relatively small number, and that the good far outweighs the bad. Thus, the answer to improving the situation is education, not regulation.

Introduction

Science youth activities in the United States involve millions of young people at the elementary and secondary school level each year. Some of the activities involve animals, and in some cases, animal experimentation. First, what are science youth activities and, secondly, what is the philosophy behind them?

Let us start by considering the types of science experiences that young people have with science when they are of school age. A teacher may explain a scientific principle to them, illustrating it with equations and diagrams on the chalkboard. A student may do a small independent research project, ending up with a science fair exhibit. A group of students may organize a science club, and engage in activities such as inviting a scientist to come and talk to them. The teacher may give the students an examination in the science that they have been studying the past few weeks. Or students may work together on a group project after school.

Now if we look at these experiences, we can see that the activities tend to fall into two kinds of groups. One group consists of activities such as classroom lectures by the teacher, recitation by the students, or required laboratory work, all connected directly with the formal curriculum and what the students have to learn.

The second group consists of independent research projects, working as a part-time assistant in a laboratory, attending lectures given by scientists, organizing science clubs, or taking a tour through a laboratory. These activities are what we call "science youth activities"—extracurricular activities in science, engineering, and mathematics,

which take place most commonly during the upper elementary and high school years.

And so we are not talking about "education" in the normal sense of the term—teaching students to pass tests and examinations by regurgitating knowledge. We are talking about something far different. This is not to say that academic achievement is unimportant. But science youth activities involve a totally different dimension, whose characteristics are quite different, and whose contributions are equally different.

And so it is that teachers, scientists and others have turned to science youth activities to attain a variety of objectives. While I cannot speak for the enormous number of persons who have been involved, here are some of the values of these activities that I see as particularly significant.

Value of Science Activities

Activities involve students in the doing of science as it actually is. Building a small wind tunnel, running a weather station, doing research on the biochemistry of fiddler crab cuticle hardening, or working as an assistant in a medical laboratory, all involve students in "doing" science. And they are in direct contrast with the preciseness and predictability of the more usual kinds of school experiences.

What is lacking in formal education is the opportunity to combine a group of such disparate interests, activities, and learnings into a single purposive and interrelated whole.

Science youth activities provide this chance, and in addition, have other characteristics that are different from the formal curriculum. They are complex, sustained over a long period of time, are often voluntary, involve recognition and formulation as well as solution of problems, and are relatively "openended" with no exact predetermined and specific answer.

In short, they resemble, though admittedly in a very simplified form, the kinds of conditions in which real scientific research is carried out, and provide a realistic introduction to research, a kind of experience that cannot be duplicated in any other way.

Activities motivate through doing. Competing in a mathematics contest, making high-speed photographs of water flowing through a pipe, building a laser, or raising termites, all are activities which involve the students in doing something.

I think we underestimate the interest of young people in taking an active rather than a passive role, and therefore the intrinsic appeal of science youth activities. Too much of the time students are talked to, lectured to, demonstrated to, showed films to, and the only breaks come when they are asked to repeat some of the information in the form of oral recitation or written test, or when they are put into a laboratory to go through certain exercises, many of which are predetermined.

Science youth activities can provide a genuine appeal through exploiting the inherent pleasure that all people have in exercising their capacities, in gratifying the urge to participate as well as to watch or listen, to do for the sheer enjoyment of doing and to experience the excitement of exploration and discovery.

Activities motivate through providing choice. Deciding to participate in a Junior Academy meeting, choosing a topic for a research project, working nights and weekends on a scientific hobby, or taking a summer job as a laboratory assistant—these are all activities in which the students make their own choice about the nature and extent of their participation.

It goes without saying that when students can take responsibility for decisions about their own activities, determining what they will do and when they will do it, there will be an increase in motivation to do their self-assigned tasks and to do them well. Moreover, such self-directed interests can provide a relevance to classroom work that might not have occurred before, providing a need and a use for the chemistry or mathematics that heretofore might not have seemed so terribly important.

For no matter what the student is doing, his own project, chosen by himself, takes on a significance far greater than it would under other circumstances, and provides a kind of challenge that is substantially different from the classroom, and to which most students respond.

Activities encourage individual responsibility for learning. Making astronomical observations, designing and constructing a computer, studying the effects of toxic rain, or solving mathematical puzzles, these are all activities which help students to take individual responsibility for learning rather than waiting for the teacher to assign them the material.

No teacher can supervise to any depth the variety of activities which students can think up, and even if he could, the complexity of modern science is such that no teacher could be equally expert in such a wide range of fields. Once the teacher has accepted the fact that the students may surpass him in their specialized knowledge, he then can freely encourage them to go ahead on their own, and so what might have been considered a difficulty can actually be turned into an important advantage. The teacher's role thus becomes one of a general advisor, suggesting sources of information or material, and encouraging the student who runs into difficulties in his project.

Science youth activities can make an important contribution to teaching individual responsibility for learning by encouraging students to explore on their own at an earlier age, in a situation where they can obtain help if they need it, and where mistakes are not as serious as they are later on in life.

Activities enable students to go into subjects in depth beyond that possible in the regular curriculum. Attending a science camp, hearing lectures by a prominent scientist, going on a tour of a nuclear reactor, all these give students information and background of a sort that is beyond that which is possible in the regular classroom situation.

They permit students to follow their own interests and curiosity. They allow them to investigate questions raised in classroom discussion but which it was not possible to answer. They permit students to go into a subject far enough to feel they really have a grasp of it. And they allow them to find out about questions for which there are no answers yet, to learn that science does not have all the answers, and to get some understanding of what is a current unanswered scientific question.

For we must realize that classroom time is really quite limited. Most all of the new curricula have a great deal more to cover than ever before and both teacher and student are under a great deal of pressure to complete the learning of vast amounts of material. This means that there is little flexibility in what can be done, and not much time is available in class to cover anything that is not absolutely essential.

Science youth activities enable students to go off into some of the nonrequired but nevertheless interesting areas of science in a way that the present classroom cannot duplicate.

Activities provide a more realistic kind of career guidance. Who knows more

about a scientific career—the student who has been limited to learning about science in the classroom and through reading and television, or the student who has also worked in a scientist's laboratory during vacation?

The answer is, I think, self-evident. Certainly, the student who has worked in a laboratory is going to have a far more accurate concept of science than he can gain from textbooks or television.

This is important, since in our modern technological society, it is increasingly difficult for young people to make career choices with any degree of certainty. They have little opportunity to observe people at work, and so must make their decisions on secondhand evidence, much of which is too superficial to be of any value.

On the other hand, science youth activities provide opportunities for them to learn about science as a career directly—from talking to scientists, from visiting them in their laboratories, from working for scientists, and from the actual doing of various kinds of scientific investigations.

Activities indicate qualities not shown in the usual examinations or tests. If a student wins a prize in a science fair, voluntarily participates in a seminar conducted by a scientist, works long and hard as a laboratory assistant, or wins a mathematics contest, what does it mean?

There is now reason to believe that many of the qualities essential to scientific success—or to success in any field—cannot be identified by our regular examinations or tests. Originality, independence, initiative, persistence, all these are qualities which our more traditional forms of testing fail to identify with any degree of accuracy.

But if a student undertakes a difficult research project, stays with it, endures frustrations and lack of progress, and finally comes up with original results, it means something. If a student participates in a seminar on his own time, it means something.

Activities enhance student performance and interest in the formal science curriculum. Almost all of the examples of science youth activities given previously—from doing research to participating in a mathematics contest—give a relevance and meaning to the formal curriculum that might not have developed otherwise.

Many a teacher can testify about the student who was never really interested in classroom work until he became involved in some extracurricular science activity. In some cases, these are bright students who never felt a challenge. In others, they are ones who simply never saw any purpose to their classroom work.

Exposure to science youth activities can in many cases "turn on" students, stimulating them to an interest in their regular work that no manner of exhortation and argument can do. And by giving their classroom efforts a significance beyond that of merely getting passing grades, they become excited and interested, and work far harder on their regular course work than they ever would have otherwise.

National Programs Involving Science Youth Activities

One of the largest group of activities involves science fairs. A science and engineering fair is a competition based on the quality of projects done by students, the results of which are presented through oral presentations and exhibits at the fair.

Fairs range in scope from the local level, which may involve one class, one school, or one district, to ones which may involve a large city, a county, a state, or even a nation. While there are no exact figures, Science Service estimates that over

1,000,000 student projects are undertaken each year in the United States and that there are fairs in some form in more than 20 other countries.

Science and engineering fairs operate on a step basis, with students who have won in small fairs participating in larger fairs as representatives of the fairs in which they have previously won. Thus, an individual might participate in a local fair, move on to a city fair, then to a regional fair and there be chosen to represent that fair in the International Science and Engineering Fair.

The International Science and Engineering Fair is held annually with some 450 student contestants from over 245 affiliated fairs in the United States and foreign nations. It culminates a selection process involving thousands of school and regional fairs, their student participants and their judges from science, engineering, medicine, and education.

The ISEF is for students in the 9th through 12th grades, and is for these young people both a competition and an educational experience. They compete for over 450 awards. Students learn through talking to the more than 500 judges, as well as through exchanging shop talk with other students and visiting universities, research centers, industry and places of cultural interest in the area where the Fair is held.

The annual Science Talent Search, now in its 39th year, identifies high school seniors in the United States talented in science, mathematics and engineering.

Greatest emphasis in the selection is placed on evaluation by scientists of an independent research project done by the student, and secondarily on answers to open-ended questions designed to elicit evidence of the student's interest and creativity in science.

Forty finalists are chosen from among 300 Honorable Mentions who in turn are selected from some 15,000 participants. The forty receive an all-expenses-paid trip to Washington to compete for scholarships and awards totaling \$89,500.

The Science Talent Search has been supported by the Westinghouse Educational Foundation and the Westinghouse Electric Corporation since its inception.

Science clubs consist of young people who engage in activities such as individual or group research, taking field trips to laboratories, hearing talks by scientists, sponsoring science fairs, or viewing science films.

A prime value of such clubs lies in the flexibility that they have to adapt to the interests and abilities of the members, since the activities do not have to conform to any specific demands. Other values lie in the motivation arising from participation, the opportunity to meet like-minded peers, and the bridge that such clubs provide young people and the community.

The annual Junior Science and Humanities Symposium (JSHS) program is composed of Regional Symposia held on college and university campuses throughout the United States, with the cooperation and assistance of universities, academies of science, public and private school systems, industry, Army and governmental organizations and installations. In 1978-79 there were 42 JSHS Regional Symposia throughout the United States.

Each symposium is unique in many respects, but one of its most notable features is that selected high school students are provided an opportunity to prepare technical manuscripts for review by experts and to present their papers orally to a large group. The program of each symposium is designed to stimulate the interest of high school students in science as a career, to put them in active contact with professionals in the various disciplines and to provide a measure of recognition within their own environment for academic excellence. Each year five outstanding students from each regional

symposium are invited to attend the National JSHS. Five of the student speakers at the National are selected to represent the United States at the London International Youth Science Fortnight.

The Annual High School Mathematics Examination aims to create and sustain interest in mathematics among high school students. Supplementing classroom work, it attempts to broaden and deepen the student's experience with mathematical concepts. In 1979, over 377,000 students from 6,425 schools participated.

The contest is both a school contest and an individual contest, with the grades of the examinations providing a basis for awards to schools and to individual students.

The top individual students in the examination are also eligible to compete for places on the U.S. Mathematics Olympiad team. This team goes abroad in the summer of each year, after attending a "training camp" in the U.S., and competes with teams from both Eastern and Western Europe.

The Science Training Program for High Ability Secondary School Students provides an opportunity for more than 2,500 students to obtain intensive experience in science and mathematics during the summer. It gives science-oriented students an opportunity for college-level instruction or investigative laboratory work. In addition, another 580 students are involved in similar activities held during the academic year.

Programs offered by participating institutions are supported by the National Science Foundation, and vary in length from 2 to 12 weeks. Some offer instruction in depth in one or more subjects. Others make the students, in effect, a junior member of a team actively engaged in scientific problem-solving under the direct supervision of a senior scientist. Others offer a combination of these two approaches by offering both classroom work and involvement in investigative-type laboratory work.

Junior Academies of Science do not have a national program, but there are so many of them that they should be mentioned. Most states have Academies of Science, and most Academies have Junior Academies of Science. Membership is generally honorary, and members are high school students.

The programs of Junior Academies vary greatly in size, and can include State Talent Searches (tied in with the national Science Talent Search), science fair sponsorship, visiting scientist programs, research grants to students, and summer training programs.

Animal Utilization

A portion of science youth activities involve animals, and part of these involve the use of vertebrates. While I do not have accurate figures, my impression is that the use of vertebrates has increased from the number used fifteen years ago. What is the reason?

One of the most important changes in science education in the past twenty-five years has resulted from curriculum revision. During this period, there have been some five hundred curriculum revision projects in the United States in all areas of science and mathematics, and for all grade levels. The impact of this has been uneven, but certainly in science projects involved in science fairs and comparable activities, the result has been a greatly increased quality and sophistication. Science fair projects that were winners twenty years ago in many cases would not even be considered today. At the International Science and Engineering Fair, and in the Science Talent Search, which involve the best in the country, much of the work can be considered to be at a college undergraduate or graduate level.

The gains have not been entirely without concomitant problems, however. For physics and chemistry projects, the problems have largely involved safety. Students are now working with lasers, radioactive materials, microwave equipment, new toxic chemicals, and so on. This has resulted in increasingly stringent rules concerning safety, both in the required laboratory work in schools as well as for independent work.

With biology, an additional problem has presented itself—the question of working with vertebrate animals—for biological projects have increased in sophistication along with the physics and chemistry projects. Inevitably, as students did more advanced work, there was a greater interest in work involving vertebrates. In addition, as students became more sophisticated in their work, there was a greater interest on the part of biochemical scientists to have them working as junior partners in ongoing research. This increased both the interest in and the contact with vertebrate experimentation.

With a greatly increased number of students working on projects involving animals, it is inevitable that there will be some projects that do not have any value or which are done without proper supervision. However, in view of the relatively small number of such projects, I feel that the good far outweighs the bad.

I know that there are some who would disagree, but I feel that such disagreement is like saying that since democracy is not perfect, we should go to some form of totalitarian government. I feel that democracy can be improved and that we should work toward that goal. I also feel that project work involving animals can be improved, and I feel that we should be working in that direction. I do not agree at all with those who take the totalitarian approach and want to completely eliminate the opportunities for young people to engage in project work and other science youth activities involving animals. The values of these activities are simply too great to support this action.

In short, I am for education and not regulation. I believe that if appropriately instructed, the young people of this country are sufficiently intelligent and sensitive to behave appropriately, and I believe that the biology teachers in their schools can be trusted to exercise proper supervision.

Comments on Other Symposium Presentations

In conclusion, I should like to direct your attention to some of the comments that have been made in previous papers.

First, I feel that there has been exhibited on the part of some of the speakers a complete and utter disrespect for the young people of this country. Over and over in statements there has been the implication that young people cannot be expected to act responsibly and do not have the ability to do good work. And I am particularly put out by the continual use of the word "children" to include high school students. It is a complete and utter putdown of bright and mature young people.

Secondly, I feel that many persons have shown a lack of respect for the biology teachers of this country. If I did not know better, I would come away with the conclusion that they were all incompetent, and that they were all irresponsible. I admit that it is my good luck to work with some of the best and brightest in this country. And I also admit that some biology teachers may not be as good as all of us would like. But I believe that most of them are competent and interested in doing a good job. If it is not all that we feel it should be, let's help them through education, and not simply sit back and criticize them.

Lastly, I am concerned about what appears to me to be a disregard for the facts

of animal experimentation at the school level that at best can be called unscientific. We have been overwhelmed with anecdotal "evidence," insufficient sample size, out-of-date data being applied to current programs, incorrect information, and out-of-context quotations.

Frankly, these problems make me somewhat pessimistic about the possibility of coming to any sort of agreement. I can only hope that if we continue our dialogue, we may be able to lessen the chasm between us.

High School Science Fairs: Evaluation of Live Animal Experimentation—The Canadian Experience

Harry C. Rowsell

Abstract

When the Canadian Council on Animal Care was established in 1968, the Council, together with representatives from the Canadian Veterinary Medical Association in concert with the Youth Science Foundation, recognized the importance of well-conceived science fair projects involving live animals. It was recognized as well that poor science encouraged poor attitudes toward the animals involved, as well as a misunderstanding of scientific investigation. Numerous schemes were tried in an effort to ensure development of proper scientific investigational attitudes as well as a respect for living things. These will be discussed, outlining where such schemes failed.

In May, 1975, Regulations for Animal Experimentation in Science Fairs in Canada were adopted by the regional representatives at the Canada-wide Science Fair in Jonquiere, Quebec. These regulations state that vertebrate animals are not to be used in experiments for projects for Science Fairs, with the following exceptions:

A. Observations of normal living patterns of wild animals in the free living state or in zoological parks, gardens or aquaria.

B. Observations of normal living patterns of pets, fish or domestic animals.

Since these regulations were adopted, the biological exhibits have increased and have shown significant improvements in scientific input involving increased numbers of bacteria, fungi, cells, sera and tissue culture. The requirement for strict supervision because of possible abuses has decreased, thus lessening the anxiety and frustration of the regional science fair committees.

Introduction

The Youth Science Foundation (YSF) is the umbrella organization responsible for all out-of-school science activities in Canada. Its objective is to develop a scientific awareness amongst pre-university students as well as to encourage scientific literacy. The Science Fair program is one of the principle activities for which the Foundation is responsible. Others include the Summer Science Program, Careers Information Service, the Rocketry Association, its publications Youth Science News and Science Affairs, Science and Engineering Clubs of Canada (SECCAN) as well as international activities on the International Coordinating Committee for the Presentation of Science

and Development of Out-of-School Scientific Activities (ICC), with its secretariat in Brussels, Belgium.

The Youth Science Foundation programs are directed primarily to the English speaking students in Canada's ten provinces and territories. The Conseil de Jeunesse Scientifique (CJS) by mutual agreement with the YSF is responsible for similar activities for francophone students. However, the CJS has for the most part, limited its involvement to the French speaking students in Quebec, where the major concentration is located.

The YSF evolved from the Canadian Science Fairs Council; therefore, it should not be surprising that the Canada-wide Science Fair is the Foundation's major activity both in terms of participants and overall cost of the program. Each year more than 50,000 students participate in local and regional science fairs. Of these a select group of approximately 200 finalists earn their way to the Canada-wide Science Fair.

The Youth Science Foundation continues to maintain the position that the prizes it offers are the most prestigious awards, albeit not having the highest monetary value. There has been a sincere attempt on the part of the Foundation to have corporations and professional associations provide reasonably monetary awards or items such as books or plaques.

The Science Fair Committees of the YSF has accepted in the past, and will continue to accept, specific corporations' awards of all-expense-paid trips to various geographic locations. For the past several years Shell Canada has given "Science Fortnight in Great Britain" awards to two Canada-wide Science Fair participants annually. Canadian Admiral Corporation Ltd. and Rockwell International Canada, Ltd. sponsor three winners to visit the NASA Space Center in California; Bell Northern sponsors a visit to its research laboratories in the Ottawa area; Syncrude Canada Ltd.—two students, three-day all expense trip to Edmonton, Fort Murray and the tar sands; Ontario Science Center—two students, all expense trip to Ontario Science Center in Toronto to display their exhibits.

The 1979 Canada-wide Science Fair held in London, Ontario, had four winning exhibits from each of the 55 affiliated Regional Science Fairs. Of these 68 exhibits were awarded prizes.

The Canada-wide Science Fair, like all activities of the Youth Science Foundation, is operated through a Committee structure. The Fair's chairman-elect serves as chairman of the Science Fair Committee the year preceding "his/her" science fair, upon completion of which he/she steps down. The Science Fair Committee develops rules and regulations concerning the Canada-wide Science Fair as well as producing, through the Executive Director of the YSF, an information package on preparation and operation of a Science Fair. The Committee also holds discussions concerning the judging of Science Fairs. Some members have from time to time suggested that competition and the presentation of monetary awards are not the best way of teaching and developing an awareness and appreciation of science. However, a majority of members continue to opt for a competitive program.

All science fairs wishing to send exhibitors to the Canada-wide Science Fair must affiliate with the Canada-wide Science Fair and must follow its regulations and rules. (Every effort is being made by the Canada-wide Science Fair Committee to ensure this is done before exhibitors are selected). Two weeks prior to the national event a list of local winners must be submitted to the secretariat of the Youth Science Foundation, including all information on the exhibitor, the project title and abstract outlining content, objectives and results. These are reviewed in order to ensure they comply with

size, contain no hazardous or dangerous compounds, and that the animal work meets the regulations. Unfortunately there are some regional science fairs that affiliate late. This produces problems because it is difficult to review protocols in order to ensure they comply with the regulations. One of the most difficult encounters is to tell student exhibitors that they cannot exhibit because their study does not comply with regulations.

At the time of the Canada-wide Science Fair a regional representatives' meeting is held to discuss all aspects of the Regional Canada-wide Science Fairs. At this meeting the regulation for Science Fairs are reviewed and any proposed changes debated. Until 1975, the regulation concerning the use of animals in science fairs were vigorously discussed. In 1975, the regional representative meeting agreed that the regulation proposed by the Animal Care Committee of the YSF would eliminate this perennial problem: students seeing exhibits over regulation size admitted, but animal studies which didn't comply with YSF regulations prohibited. This created a major problem for exhibitors. Elimination was psychologically disappointing and frustrating. The new regulations were specific. The students knew exactly the limitations regarding the use of animals. Since that date, the regulations for animal experimentation as presented in Appendix 1 have been in effect.

The Role of the Canadian Council on Animal Care

When the Canadian Council on Animal Care (CCAC) was established in January 1968 (Rowsell, 1974), numerous complaints were brought to the attention of the CCAC secretariat concerning the abuse of animals by youthful exhibitors in Science Fairs.

Although the CCAC had been established specifically to develop guidelines for the improvement in the care of experimental animals at the university and research levels, nevertheless its terms of reference, which were purposely made very broad, stated that the Council was "to work for the improvement in the care and use of animals on a Canada-wide basis." Such terms gave the Council the ability to make recommendations for improvements in the procurement and production of experimental animals, the facilities and care of experimental animals and the examination of procedures in experiments involving animals. Thus, the CCAC quickly became involved in the use of animals in experiments at the pre-university level. Its initial priority was at the level of the use of animals in science fairs.

The Council consists of representatives from 14 agencies. The chairman is appointed by the Association of Universities and Colleges of Canada (AUCC) which organization has two further seats in the CCAC occupied by academies with arts and humanities affiliations. Two seats on Council are filled by representatives of the Canadian Federation of Humane Societies (CFHS) representing over 200,000 members. The remaining agencies on Council have one representative each. The majority of representatives on Council had heard about some of the studies involving animals being exhibited at Canada-wide Science Fairs which has resulted in unnecessary pain and distress. The CFHS representative had been requested by their membership to ensure the CCAC address itself to the problem in order to stop this frivolous and unnecessary use of animals.

The Canadian Veterinary Medical Association (CVMA) having heard similar concerns expressed, appointed the Executive Director of the CCAC as its representative on the Board of Directors of the Youth Science Foundation.

The Youth Science Foundation and its Science Fair Committee were aware that

each year there were numerous complaints about the use of animals in science fair projects which brought bad publicity to the Science Fair both regionally and nationally. It was always those projects that were poorly conceived and carried out, causing pain and distress to animals, that received most publicity through letters to the editor or press reports in the local media or by direct complaints to the Regional Science Fair Committee or the Youth Science Foundation secretariat.

The Board of Directors of the YSF and the Science Fairs Committee quickly requested that the Executive Director of the CCAC and representatives of the CVMA develop an animal care committee whose responsibility it would be to advise the YSF on rules governing the use of animals in Science Fairs. Subsequently a six-member Animal Care Committee, chaired by the Executive Director of the CCAC, with representatives from the Ontario Veterinary Association, and L'Ordre des medecins veterinaires du Quebec discussed the issue and developed initial regulations. The CVMA in order to encourage humane treatment of animals decided to present an annual award called the CVMA Science Fair Award with presentation based on the criterion that: "the winner should have expressed a scientific approach to the study which exemplified humane care and use of animal resources."

Additionally, two CVMA members joined the judging committee in order to choose the winner and assist the committee on all animal projects.

Untrained Students and Ill-Treated Animals

The CCAC and YSF Animal Care Committee recognized that because the Science Fair program had "grown like topsy," certain students prepared projects involving animals based upon articles in the popular press, or a science or nature program on television. In most cases the students undertaking projects involving animals would not discuss their plans with people familiar with the subject. Often they were too inexperienced to understand their own results, and typically they were unfamiliar with the basics of animal care and humane treatment; although no cruelty was intended, they simply did not understand and recognize they were in fact, causing suffering in the animals. The result, unfortunately, was often suffering for the animals with little benefit to the student with respect to developing an understanding of science methodology. Unfortunately, in some cases the student would receive an award of prize money because the judges themselves did not recognize that unnecessary suffering and distress had been caused and that the project actually was more spectacular than scientific.

Previous "bad press" that developed was exemplified by an article in the Hamilton Spectator following the 1970 Canada-wide Science Fair held at McMaster University in Hamilton, headlined "Science or Sadism?" It described a project in which rats had been exposed to nail polish remover until they died from liver and bone marrow destruction. The student responsible was unable to recognize the cause of death.

Projects such as these were far beyond the students' level of training and comprehension. They inflicted useless suffering on experimental animals and failed to achieve the objective for which the Science Fair was instituted in the first place, namely a proper understanding and appreciation of scientific investigation, thus a scientific awareness. Such studies failed to develop responsible attitudes toward the care and use of animals. Such a lack of responsibility was obvious in the community in general where there were increasing numbers of unwanted dogs and cats being destroyed annually. Although selected as companion animals, they were often disposed of in a cruel manner, usually to fend for themselves on the streets or discarded in rural areas in surroun-

dings both hostile and unknown. Hopefully, attitudes developed by the rules and regulations established for animal use at the Science Fair level may create a more responsible society as these young people take their place in a mature world.

Development of Guidelines for Animal Use

The Youth Science Foundation developed initially a Canadian code of judging principles and standards for use at the Canada-wide Science Fair and the affiliated regional science fairs. The Animal Care Committee of the YSF presented to the Science Fair Committee and to the CCAC, Guiding Principles for Animal Care. The first principles proposed merely that certain projects involving vertebrate animals must be undertaken only under the supervision of an adult experienced in that field of research. A list of experts was developed by the Canadian Federation of Biological Societies (CFBS). Regional Science Fairs were notified of the existence of this list and students were sent letters indicating the availability in their area of scientists willing to assist in biological projects. This was a laborious procedure requiring considerable paper work and correspondence. Unfortunately, most students proceeded along on the projects on their own without consultation or advice from the scientist consultants.

The guiding principles were changed when it was recognized that students were continuing to undertake projects well beyond their level of comprehension unwittingly causing pain and distress to animals. The new version emphasized that any project involving vertebrate animals should not be undertaken if it caused pain or affected the health of the animal. At the time of the Canada-wide Science Fair as well as at the time of Regional Science Fairs, students apparently failed to recognize abnormalities in the health of the animal, or misinterpreted indications of distress. Following experience with animal projects in the 1971-72 Science Fair program, the guidelines were further revised in September, 1972, to describe specifically those animal studies which were prohibited (Secord and Rowsell, 1974). These guidelines stated that:

A. No experimental procedures shall be attempted on a vertebrate animal that would subject it to pain or distinct discomfort or interfere with its health.

B. Surgery shall not be performed on vertebrates.

C. Experimental procedures shall not involve the use of microorganisms which cause diseases in man and animals, ionizing radiation, cancer producing agents, chemicals at toxic levels, drugs known to produce abnormal side effects or capable of producing teratogenic effects.

D. Experimental treatment should not include electric shock, exercise until exhaustion, or other distressing stimuli.

E. Food should be palatable, of sufficient quantity and balanced to maintain a good standard of nutrition. Clean drinking water should be available at all times. Food shall not be withdrawn for longer than 12-hour periods. Containers for food and clean water shall be of a design, made specifically for that purpose.

F. If egg embryos are subjected to experimental manipulations, the embryo must be destroyed humanely by the 19th day. If normal egg embryos are to be hatched, satisfactory humane considerations must be made for disposal of chicks.

G. All experiments shall be carried out under the supervision of a competent science teacher. It shall be the responsibility of a qualified science teacher to insure the student has the necessary comprehension for the study to be undertaken. Whenever possible specifically qualified experts in the field shall be consulted.

It would appear that these guidelines for science fairs would have the necessary information and requirements to insure that animals in science fair projects would not be subject to unnecessary pain and suffering.

As a further safeguard, the YSF Animal Care Committee of the YSF called upon veterinarians and scientists experienced in animal care to serve on animal care committees for the regional science fairs. The Board of Directors for each fair was asked either to accept a member of the Youth Science Foundation on their own animal care committee or set up a committee of their own choosing. They were asked also to invite a member of the animal care committee to attend meetings of the regional fair committee, to insure that the Board of Directors understood the animal care guidelines and their own responsibilities. The animal care committee was required to insure that all projects involving animals met the guidelines and their own responsibilities. Finally, it was required to insure all projects involving animals met the guidelines before the regional science fair was opened to judging and to the general public. The Animal Care Committee of the YSF created an additional safeguard by enforcing the means of insuring the application of the guiding principles, through an affidavit of approval for any project involving living, vertebrate animals (Appendix 2). Without completion by the regional animal care committee chairman the project could not be shown. In order to obtain an affidavit the student contemplating such a project had to complete a questionnaire describing among other things, the purpose of the experimental study involving animals and the procedures they intended to carry out. Once the affidavit of approval was issued the students were not permitted to change any of their experimental procedures without the prior approval of the animal care committee.

In the Province of Ontario the Animals for Research Act requires that research using animals cannot cause unnecessary pain or distress. The affidavit of approval was accepted as evidence that the project met the requirements of the Act. Additionally, veterinarians and inspectors from the Veterinary Services Branch from the Ministry of Agriculture and Food visited each of the regional science fairs in Ontario.

It was considered that this program would eliminate improperly-designed studies and preclude the objectionable studies causing pain and distress in animals that had plagued the science fair program in Canada for so many years. Instead, it was found that some chairmen of animal care committees signed affidavits without closely examining the procedures and the scientific merit of the project as a worthwhile learning experience for the student.

Following the Canada-wide Science Fair in 1974 held in Calgary, Alberta during which one or two projects, albeit with signed affidavits of approval, violated the guidelines, the Animal Care Committee of the YSF met and decided that these continued, unnecessary abuses of animals in science fair projects must end. Indeed, one member who had acted as a judge in one of the large regional science fairs stated that those projects involving animals were the poorest designed and the worst science of any projects in the science fair. It was the desire to see all projects involving animals prohibited. The committee would not endorse this request. However, it recognized that despite the efforts that had been made improvements were necessary.

The Solution

In May 1975, Regulations for Animal Experimentation in Science Fairs in Canada were presented to the regional representatives at the Canada-wide Science Fair in Jonquiere, Quebec. These regulations which had been developed by and given approval

of the Animal Care Committee of the YSF and the Canadian Council on Animal Care, were adopted without modification or amendment (Appendix 1). These regulations state that vertebrate animals are not to be used in experiments for projects for science fairs, with the following exceptions: a) observations of normal living patterns of wild animals in the free living state or in zoological parks, gardens or aquaria; b) observations of normal living patterns of pets, fish or domestic animals.

Since these regulations were adopted, the biological exhibits have increased and shown significant improvements in scientific input involving increased numbers of bacteria, fungi, cells, sera and tissue culture. The requirement for strict supervision because of possible abuses has decreased, thus lessening the anxiety and frustrations of the science fair committees and eliminating the adverse publicity that had followed so many of the previous science fairs.

It has been the Canadian experience, regrettably, to learn the hard way. We should have listened to the statement of Dr. Chauncey D. Leake, Professor of Pharmacology of Ohio State University when he wrote: "It seems to me that it is wise to avoid getting our youngsters so enthused over biological sciences that they are anxious to undertake extensive animal experimentation without the background, the experience, the judgement, or the ways that are necessary in handling animals appropriately for complicated biological experimentation" (Animal Welfare Institute, 1960).

Because of our mistakes in attempting to develop programs that on paper sounded excellent but in practice were impractical and unenforceable, we saw the need to turn to a recognition by ourselves and students proposing studies that lower orders such as bacteria, fungi, protozoa and insects can reveal much basic biological information. We were pleased to encourage Dr. Barbara Orlans (1977) in the preparation of her book entitled "Animal Care from Protozoa to Small Mammals". The diverse selection of organisms for study noted in this publication encourage a proper understanding of the science of life and scientific technique. The student wishing to pursue a career in the biological sciences is provided with information of such clarity that all aspects of any experimental studies involving the species listed in this book should be within his or her comprehension and capabilities.

The Canadian Council on Animal Care, following the acceptance of the regulations for animal experimentation in science fairs and their implementation, turned to the need to insure proper guidelines governing the use of animals in the classroom at the pre-university level. To this end guiding principles in this regard (Appendix 3) were prepared for use by Departments of Education and Boards of Education across Canada to ensure adequate safeguards exist for the proper care and use of animals in experimentation in the classroom. It is emphasized that *"these guidelines are not for use by students preparing projects for exhibit in science fairs. Students preparing projects for science fairs must adhere to the Youth Science Fair Regulations for Animal Experimentation, as prepared and distributed by the Youth Science Foundation."*

Along with these guidelines were distributed suggestions for experiments involving animals at the pre-university level (Appendix 4). Additionally, collaboration has been undertaken with various high school educational authorities in preparation of manuals and course outlines, involving animals and teaching programs at the pre-university level (Bartlett *et al.*, 1972; Frontenac County Board of Education *et al.*, 1972).

It is essential that man continue to use animals in scientific exercise striving at all levels to insure proper stewardship of these animals, recognizing that even the Judeo-Christian ethic of man's dominion over animals carries concomitant obligations toward them. The replacement of animals in the classroom or science fair is possible and

should be encouraged (Borden and Herrin, 1972; Godwin, 1979; FRAME, 1979). Therefore we must recognize our responsibility for insuring stewardship to insure the prevention of pain and suffering amongst animals (Rowsell and McWilliam, 1980). All those using animals must be consistent in recognizing that creatures be treated equally and not designated as first class, second class, etc. Snakes have the same rights as do dolphins, whales and seals. All are vertebrates. All can feel pain. Only human beings can recognize and prevent pain and suffering amongst their animals. This is the objective of the Canadian Council on Animal Care in insuring proper use of animals in science fairs or in the classroom at the pre-university level.

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Appendix 1

Regulations for Animal Experimentation in Science Fairs

A. Biological experimentation is essential for an understanding of living processes. Such studies should lead to a respect for all living things. Capable students, anxious to pursue a career in biological sciences must receive the necessary encouragement and direction. *All aspects of the project must be within the comprehensions and capabilities of the student undertaking the study.*

B. Lower orders such as bacteria, fungi, protozoa and insects can reveal much basic biological information. If experiments are to be conducted on living subjects for science fair projects then only lower orders of life may be used.

C. Vertebrate animals are not to be used in experiments for projects for science fairs, with the following exceptions:

1. Observations of normal living patterns of wild animals in the free living state or in zoological parks, gardens or aquaria.
2. Observations of normal living patterns of pets, fish or domestic animals.

D. No living vertebrate animal shall be displayed in exhibits in science fairs.

E. Cells such as red blood cells, other tissue cells, plasma or serum purchased or acquired from biological supply houses or research facilities may be used in science fair projects.

F. Observational type studies on only chicken egg embryos may be used in science fair projects. If normal egg embryos are to be hatched, satisfactory humane considerations must be made for disposal of the chicks. If such arrangements cannot be made then the chicken embryos must be destroyed on the 19th day of incubation. No eggs capable of hatching may be exhibited in science fairs.

G. All experiments shall be carried out under the supervision of a competent science teacher. It shall be the responsibility of the qualified science teacher to ensure the student has the necessary comprehension for the study to be undertaken. Whenever possible specifically qualified experts in the field shall be consulted.

For information and names of qualified experts write to:

Canadian Council on Animal Care
1105-151 Slater St.
Ottawa, Ont.
K1P 5H3 Canada

Youth Science Foundation
302-151 Slater St.
Ottawa, Ont.
K1P 5H3 Canada

Accepted by Regional Representatives, Canada-Wide Science Fair, May 23, 1975

Appendix 2

YOUTH SCIENCE FOUNDATION
ANIMAL CARE COMMITTEE

AFFIDAVIT

FOR USE OF ANIMALS IN YOUTH SCIENCE PROJECTS

This is to Certify that

NAME OF STUDENT

ADDRESS OF STUDENT

SCHOOL NAME

Has received the approval of the Animal Care Committee to show this project involving experimental animals. The project has followed the Youth Science Foundation guiding principles for animal experimentation at the pre university level.

DATE

CHAIRMAN
REGIONAL ANIMAL CARE COMMITTEE
YOUTH SCIENCE FOUNDATION

Appendix 3

Guiding Principles Governing the Use of Animals in the Classroom at the Pre University Level

I. Purpose

These guiding principles have been prepared by the Canadian Council on Animal Care. They are recommended for use by Departments of Education and Boards of Education across Canada in order to ensure adequate safeguards exist for the proper care and use of animals in experimentation in the classroom, in the schools, in their jurisdiction.

These guidelines are not for use by students preparing projects for exhibit in Science Fairs. Students preparing projects for Science Fairs must adhere to the Youth Science Fair Regulations for Animal Experimentation, as prepared and distributed, by the Youth Science Foundation, Suite 302, 151 Slater St., Ottawa, Ontario K1P 5H3.

II. Philosophical Considerations

Biological experimentation involving animals in the classroom is essential for an understanding of living processes. Such studies should lead to a respect for all living things. All aspects of the study must be within the comprehensions and capabilities of the student undertaking the study.

Lower orders of life are preferable subjects for experimentation at the pre university level. Such lower orders as bacteria, fungi, protozoa, and insects can reveal much basic biological information; they should be used for experimentation, wherever and whenever possible.

III. Care of Experimental Animals

The care of experimental animals in the school should embody the principles laid down in the *Care of Experimental Animals, a Guide for Canada*, as prepared and distributed by the Canadian Council on Animal Care.

The following principles are necessary in order to provide optimal animal care:—

A. The maintenance of animals in a classroom shared by students on a long term basis, is not recommended. Therefore, animal quarters specifically for housing of animals should be provided.

B. All experimental animals used in teaching programs must be properly cared for. Animal quarters should be made comfortable by provisions for sanitation, protection from the elements and have sufficient space for normal behavioural and postural requirements of the species. The living quarters shall have surfaces that may be easily cleaned, good ventilation and lighting, well regulated temperatures and cages of sufficient size to prevent overcrowding. Animals must be protected from direct sunlight or other environmental factors which may disturb the well-being of the animal.

C. Food should be palatable, of sufficient quantity and balance to maintain a good standard of nutrition. Animals shall not be allowed to go below the maintenance level of nutrition. Clean drinking water shall be available at all times. Containers for

food and water should be of a design, made specifically for that purpose.

D. Colonies and animal quarters shall be supervised by a science teacher experienced in animal care. The students and other animal care staff shall be trained and required to handle the animals gently and humanely.

E. All animals must be disposed of in a humane manner. If euthanasia has to be carried out an approved humane method must be used and carried out by an adult experienced in the use of such procedures.

F. The use of animals must comply with existing local, provincial or federal legislation.

G. The procurement and use of wild animals and birds must comply with the Migratory Birds Convention Act of Canada, the Convention on International Trade on Endangered Species of Wild Fauna & Flora (ratified by Order in Council July 3/75) as well as any existing legislation at the provincial level concerned with wild animals and exotic species.

IV. Experimental Studies

A. All experiments should be carried out under the supervision of a competent science teacher. It is the responsibility of the qualified science teacher to ensure the student has the necessary comprehension for the study to be undertaken.

B. Students should not be allowed to take animals home to carry out experimental studies. All studies involving animals must be carried out in a suitable area in the school.

C. All students carrying out projects involving *vertebrate animals* must adhere to the following guidelines:—

1. No experimental procedures shall be attempted on a vertebrate animal that should subject it to pain or distinct discomfort, or *interferes with its health*.

2. Students shall not perform surgery on vertebrate animals.

3. Experimental procedures shall not involve the use of:—

a. microorganisms which can cause diseases in man or animals.

b. ionizing radiation.

c. cancer producing agents.

d. drugs or chemicals at toxic levels.

e. alcohol in any form.

f. drugs that may produce pain.

g. drugs known to produce adverse reactions, side effects, or capable of producing birth deformities.

4. Experimental treatments should not include electric shock, exercise until exhaustion, or other distressing stimuli.

5. Behavioural studies should use only reward (positive reinforcement) and not punishment in training programs.

6. If egg embryos are subjected to experimental manipulations, the embryo must be destroyed humanely 2 days prior to hatching. If normal egg embryos are to be hatched, satisfactory humane considerations must be made for disposal of the young birds.

D. The use of anaesthetic agents, by students, is not recommended and in the case of some anaesthetics not permitted by law.

E. Information on the care, housing and management for individual species, as well as suitable experiments for use at the pre university level, may be obtained from the Canadian Council on Animal Care, 151 Slater St., Suite 1105, Ottawa, Ont. K1P 5H3.

Appendix 4

Suggestions for Experiments Involving Animals at the Pre University Level

In order to give guidance to Youth Science Fair participants, Biology Teachers and Science Fair Directors, the following presents ten broad acceptable areas of animal experimentation at the pre university level. It is supplementary to the Source of Information on Animal Care and Experimentation for Pre University Biology.*

A. Physiology—measure normal physiological parameters such as respiratory rate, heart rate, temperature, eating habits, measurement of the length of the time dye-markers take to pass through the gastro intestinal tract and appear in the feces. Fecal output, urine production measuring when animal is fed greens as source of water as compared to water ad lib.

B. Reproductive Biology may be done with mice, hamsters, gerbils or rats, allowing the species to be studied to live under a variety of conditions. Studies may be repeated on the same animals because of the short gestation. The animals may be treated in the following manner or modifications of these.

1. Before breeding the animal is gently handled and given kind treatment by the student each day. After breeding the gentling continues.

2. A second group of animals does not receive this gentling treatment but instead are left in their cages to breed.

3. A group of animals are placed in a darkened room and not allowed any light, one group is removed each day and handled and the other group is not. Many variations of this may be carried out without causing any distress to the animal. The number of the young-born is observed and recorded in the same manner the number of young weaned is observed. Additionally, in the study one can also look at the habits the animals have with respect to the provision of proper bedding materials or nest boxes etc.

C. Maze studies—many variety of studies can be carried out using mazes, all with positive reinforcement, timing the animals, again modifying the handling of the animals, modifying the type of environment in which the animal lives i.e. darkness, light, exposure to soft music, rock music four to six hours a day etc. All of this is given on positive reinforcement, no electric shock or food deprivation etc.

D. Behavioural studies—The effect of enriched environments on the behaviour of the animals, i.e. provision in a gerbil's cage of bottles, containers in which the animals may wish to live; the studies of an enriched environment as compared with an environment in which only the necessities are provided such as water, food. The student may let his imagination carry into many areas by providing balls, round objects, square objects, etc. etc. Many psychology departments have basic studies in which behavioural scientists look at the effect of enriching an environment. This has good application to modern day human sociological problems.

E. Nutritional Studies—Again none of these studies should involve producing deficiencies and disease in the animals; however, there are many studies that can be

*Available from Canadian Council on Animal Care, 151 Slater St., Ottawa, Ontario K1P 5H3 or Youth Science Foundation at same address.

carried out where animals can eat a balanced diet, for example one diet fed in a cube state giving recognition that most of the rodents are gnawers; then another group fed on a powdered ration or a meal mixture and a third group fed on a ration which is moistened by water. The animals should be in a growing stage; they are weighed each day and measurements such as body weight gains recorded. In this the student learns to handle the animal and to make accurate measurements. In such studies fecal and urinary output are possible adaptations.

F. Environmental Studies—Again in this area light, darkness, temperature may be measured against weight gains in young animals or food intake or urinary output. The animals can be maintained in the darkness, handled or not handled and then brought into the light; handled regularly and increasing or decreasing weight gains observed under these different regimens. With respect to temperature only a normal temperature for the animal should be studied or one where the temperatures are increased five to ten degrees above the recommended normal maintenance temperature for the animal. For example, if the normal temperature for rats is considered as 72° Fahrenheit then raising the temperature to 78 or 80 degrees could be studied. It is not recommended that anyone should study effects of temperatures above 80° F or below 65° F.

G. Anatomical Preparations—The bodies of dead animals may be obtained from humane societies or research laboratories where animals have been killed humanely. The preparation of skeletons from these animals, cleaning the bones and restructuring the body is a giant task. Comparison of the various bones in animals is another interesting detail, particularly if function is also brought into the study.

H. Genetics—Under this heading, various colours of mice or rats, hamsters or rabbits may be bred and the colour adaptations recorded. Similarly, in this one can study the effects of random breeding, brother and sister matings, and line breeding with respect to number of young-born, colours, sex, etc.

I. Field Studies—Data collecting of information concerning numbers of wild animals within a given area i.e. woodpecker population in an area close to an industrialized or a built up area and one far removed. There are all kinds of combinations of studies that can be made studying the influence of various changes in the environment inflicted on the animal by man. Into this study as well one could build feeding stations and study bird population or animal populations as they arise. One such field study that would be worthwhile would be observation of animals in a dump.

Study of the senses—studies on sight, smell, taste, the type of exposure should be on only those things which we may contact daily. Various studies can be done here where behaviour of animals can be observed when exposed to various colours in their environment, or by the exposure of the environment say of a heavy peppermint smell or an onion odour. Ordinary food stuffs fed laboratory animals can be coloured with vegetable dyes or can be altered with respect to taste by adding spices etc. Nothing should be added which would be regarded as unacceptable to human senses.

September 1976

The Challenge and Motivation of Students through Live Animal Projects

Thurman S. Grafton

Abstract

The subject of use of live animals by secondary schools either in classroom work or science fairs is a very controversial and often emotional issue. The author emphasizes the dedication to humane treatment of animals while at the same time explaining the process by which rules have been formulated to provide for the appropriate use of live animals. The difference between permission and mandate is clarified for the purpose of explaining the need to provide for the more effective challenge and motivation of the high achiever while still allowing for more modest undertakings by the average student. The perils of overregulation are stated. Recommendations for the further improvement of the program are offered.

Introduction

The biomedical scientific community has a serious responsibility to participate in the development of its own replacements from subsequent generations. We have learned the problems of affirmative action for admission to professional and graduate schools must be addressed to preparation at the elementary levels of education in terms of basic learning of reading, writing, and mathematical skills. Likewise, it is important to introduce students to the biological sciences early in the educational process if motivation for career in the biological, life, and health sciences is to be achieved (NABT, 1966).

Educators generally agree that participation of students is one of the crucial ingredients in learning. Individual research projects are one means of insuring student participation. The proper use of live animals in science fair competitions has been recognized as one that generates enthusiastic participation (Bellipanni, 1977).

An article by W. B. Cannon, M.D., Professor of Physiology at Harvard, in 1912 clearly identified the significant difference between observation and the experimental method. He placed this transition at about 1850. Prior to then "to account for sickness, all sorts of theories were advanced such as bad air, the influence of stars and mysterious humours and myasisms; but these theories were subjected to almost no experimental tests." (Cannon, 1912) Thus the scientific method was established.

Many secondary school students will not continue into higher education. This represents a greater challenge to the teacher to stimulate and motivate the student to pursue these lines of study. For these, the occasion to participate in a well-planned in-

dividual research project, with or without animals, may be their only introduction and opportunity to understand the scientific method. This valuable lesson is essential preparation for adult responsibilities.

John Dewey (1931), the famous philosopher, stated in his publication, "Ethics of Animal Experimentation":

Different moralists give different reasons as to why cruelty to animals is wrong. . . . There is, however, no ethical justification for the assumption that experimentation upon animals, even when it involves some pain or entails, as is more common, death without pain—since the animals are still under the influence of anesthetics—is a species of cruelty. Nor is there moral justification for the statement that the relations of scientific men to animals should be under any laws or restrictions save those general ones which regulate the behavior of all men so as to protect animals from cruelty.

Dewey (1931) made a significant contribution when he reworded his truths to state them positively as follows:

- 1. Scientific men are under definite obligation to experiment upon animals so far as that is the alternative to random and possibly harmful experimentation upon human beings, and so far as such experimentation is a means of saving human life and of increasing human vigor and efficiency.*
- 2. The community at large is under definite obligations to see to it that physicians and scientific men are not needlessly hampered in carrying on the inquiries necessary for an adequate performance of their important social office of sustaining human life and vigor.*

These comments are quite interesting in light of the current series of seminars on ethics which have been occurring this year. The point is that we do not have to deal in terms of absolutes. If we want humane treatment of animals, we impose rules or guidelines that will provide for that. If the concern is that the students are not adequately prepared to carry out such efforts one of two things should happen on a one-on-one basis:

- A. The individual project may be discouraged, or alternatively,
- B. The necessary preparation will be provided.

Human behavior, and more specifically the behavior of students, in any population follows the same statistical distribution characterized by the Bell curve. All youngsters are not bad. In this application, for every extreme case of a young person that might have a tendency toward cruelty to animals, there is another on the other end of the distribution that would risk life and limb to return a baby sparrow to its nest. Most of the population fall in between and would be categorized as good and kind.

The position of both the National Society for Medical Research (NSMR) and the International Science and Engineering Fair (ISEF) is that secondary school students with proper supervision can conduct animal experimentation in a manner that will challenge and motivate their interest in the biological sciences and still assure humane treatment of the animals (Grafton, 1977).

Development and Content of ISEF Rules

The Rules for the ISEF (Science Service, 1979a) are promulgated by what was formerly the Committee on Animal Experimentation and is now the Scientific Review Committee. The committee consists of high school science teachers who are active in the classroom, administration, and in local or regional science fairs and veterinarians who are specially qualified for this responsibility. In the three years I have been associated with the program, there have been three charter members of the American Association of Animal Welfare Veterinarians on the committee. The current rules had input from three Diplomates of the American College of Laboratory Animal Medicine. After drafting by this committee, they are reviewed and approved by the Director of Science Service, Inc. the sponsor of the ISEF.

The first section of the rules that relates to animal research is not only dedicated to, but emphasizes the humane considerations vital to any use of animals. This was not just an accident of format. It was deliberate to direct attention to the importance of the subject as the first and foremost thing that must be considered.

The mandated preparation of a protocol **BEFORE** undertaking any animal work is mainly for two purposes: (1) to cause the students to think through what it is they are looking for, how they propose to find out, and what methods will be involved and (2) to enable the teacher or supervisor to determine the appropriateness of the project and the degree of supervision it will require.

The most important decisions to be made at this early stage involve the selection of a subject and the animal species to be used. Students are encouraged to utilize lower forms of life including protista.

The most critical rules that make a more liberal approach to animal use possible are the detailed requirements for documentary certification of the student research by appropriate adult supervisors. These include where indicated:

A. Teacher-Supervisor: The teacher or supervisor agrees to assume responsibility for compliance with the ISEF rules.

B. Animal Care Supervisor: This certification covers primary responsibility for the quality of animal care, including both continuing supervision, and euthanasia of the animals, if required at the termination of the project.

C. Biomedical Scientist: A biomedical scientist is described as qualified to the doctoral level with a working knowledge of the techniques to be used by the student. The scientist certifies to ensure training, give advice and supervision, and have read the ISEF rules.

D. Designated Adult Supervisor: This is a fully qualified individual designated by the Biomedical Scientist to provide the direct supervision to the student after training by the Scientist.

The rules also contain specific references to federal laws, regulations, and guidelines that might impact on student research. This is most important where there may be involvement with lasers, controlled substances, human subjects, recombinant DNA, etc.

Some of the critics of the program have characterized it as "elitist" because of

the emphasis on competition and complex projects. This is an area of endeavor in which I feel elitism is a good thing. For many years there has been a movement in our society in the name of egalitarian equal opportunity for all which has resulted in reducing the opportunities for the outstanding while doing little to increase the lot of those most in need of help. Policies in this direction have had a very undesirable effect as evidenced by the lowered scores on college entrance exams. This in turn brought about the imposition of legally mandated tests for competency before high school graduation already enacted by some levels of government.

The rules for the actual exhibits permitted are very explicit to avoid misunderstanding. These were developed over the years to cope with problems affecting safety and public health. It was these concerns that years ago decreed that no live animals be exhibited. This also avoids what would otherwise be a stressful situation for animals. Health hazards are the reason we prohibit cultures of microorganisms.

The other major factor about exhibits is the matter of whether all or part of an exhibit is appropriate. Following judging, the science fairs are not only open to the public, but they are promoted as family affairs. Parents are encouraged to bring all the children to see what marvels of science their siblings and peers have accomplished. Just as the porno magazines are covered on the newsstands, the rules provide that pictures of animals in other than normal conditions which might be visually offensive to some, may not be displayed. Students are encouraged to have whatever pictures they feel necessary to describe their work mounted in their notebook for review by the judges.

Importance of Adult Supervision

As indicated above, we feel that the success of the entire science fair program is dependent upon the quality of adult supervision that is provided. It is the adult supervisors that motivate, inspire, educate, evaluate and generally keep the student out of trouble. Some of the specific functions in the area of animal research of paramount importance are:

A. *Define reasonable parameters:* One of the basic elements of an ordered society is to clearly define the rules of the game. If you read our rules carefully, you will see that this is emphasized, wherever appropriate as before the fact, not after the fact. In this instance, it includes an evaluation of the capabilities of the student, resources and supervision available.

B. *Advise on preparation of the protocol:* This is where the suggestions of subject, species, and methodology are employed.

C. *Refer to qualified biomedical specialist:* There is absolutely no stigma associated with high school biology teachers recognizing their own limitations and referring students to a specialist in a particular area of research. This is the same principle as a physician in general practice referring a patient to a specialist when the nature of the problem exceeds the capabilities of the generalist.

D. *Continuing supervision:* The importance of adult supervision at all stages of the student/animal research cannot be overemphasized. It must be continuous **BEFORE**, during, and following the animal phase. The before and during have been referred to

previously. The responsibilities following include: evaluation of the results promoting sensitive understanding of death, and advice on writing scientific reports.

E. *Evaluation of results*: This aspect of the scientific method is critical. It is here that the supervisor helps the student to perceive and interpret the cause and effect relationship of the research. The concept of significant variation versus random chance is introduced in a subtle, but understandable way. The rejustification of the methodology and animal use in light of study results is an important learning outcome.

Dangers of Overregulation

There is a serious danger in the tendency toward overregulation which as citizens of this country we all recognize. You have all heard how the cost of compliance with federal regulations increases the cost of an automobile by \$800. At a symposium on the ethics of animal research, Theodore Mich, the lawyer on the program, suggested that most of the meeting's participants were legal laymen of the era of 1929 when the answer to all societal ills was "There ought to be a law!" He stated the history of law has involved progression from definition to prohibition to management. Today it is moving away from direct government controls to less intrusive legal devices such as planning, goal setting, discretionary funding and fact-finding (Meth, 1979).

The rules that have been published and distributed for the 31st ISEF have already been the subject of criticism from the very persons they were designed to help the most—the high school science teachers. The complaint is that they are so very complex one needs to be a lawyer to interpret them.

The fact is that this set of rules has been expanded to recognize a demonstrated interest in student research involving not only the use of live animals, but human subjects, and recombinant DNA technology. The easy course for the committee would have been very simple, prohibit them all. The committee and the directors of the program took a more responsible, although more difficult, line of providing rules within which these new, popular challenges could be met and controlled.

A most important factor in legislation or regulation by the government or rule preparation in a science fair must be recognized and appreciated. That is the difference between permission and a mandate. Oversimplified this is the difference between "you may" and "you shall."

In preparing the rules, we have attempted to make provision for the very outstanding student who is capable of handling highly sophisticated work, and who would probably be invited to summer science programs at a university or other research facility to work with leading scientists. There is nowhere the suggestion that every student should undertake the same level of complication in their research. But, the door must not be closed to those who are high achievers.

To make the rules any more complicated, or to superimpose added laws and regulations at the federal or state level would be to place an additional paperwork load on the already overburdened teachers and administrators (Grafton, 1979a).

Targeting the use of animals specifically for tighter regulation would tend to divert student interest to other subjects. This is why we see finalists in the Westinghouse Science Talent Search, whose career goals are in medicine, with exhibits of projects in physics and theoretical mathematics (Science Service, 1979b).

Students diverted in their interests in this way may be permanently lost to the biomedical and life sciences. As our population stabilizes in numbers, the number of

young people to enter any given career pattern is less in absolute numbers. Still, with better health programs prolonging life, the needs for input of students into the biomedical sciences to provide for the needs of an aging majority of the population is greater than ever.

Suggested Areas of Improvement

It is essential that even though we embrace new technologies, we must keep rules simple enough for all to understand. It is regrettable, but true, that the reading comprehension level of secondary school students has fallen off to the point that previous guidelines must be rewritten in simpler language.

Local and regional science fairs must adopt ISEF rules. One clearly recognized advantage of the program in Canada is the fact that there is one set of rules governing science fairs that is applicable at all levels. In this country there is a strong sentiment in some areas for "State's Rights" particularly in terms of laws or regulations. The problem in the science fair program arises when local or regional fairs pick and choose those elements of the ISEF rules they want to apply and ignore the rest. Sometimes this is in a sincere effort to simplify what has become complex, but the fact remains that the ISEF rules were promulgated by experts to do it right. Anything less is courting problems.

As modern technology has been reflected in college curricula, we find that the preparation of science teachers, even if they majored in science (Biology majors are not even offered at most colleges today) do not get the kind of "hands on" experience in laboratories working with live animals that is needed. Therefore, the solution to one of the most pressing needs that would do the most good in helping to improve the quality of adult supervision of student animal research would be continuing education courses on live animal work for secondary school science teachers. This could be in the form of in-service training, or in summer programs at universities (Grafton, 1979b).

Help must be provided to the science teachers to identify scientists willing to work with students. This kind of help is available not only at the nearby medical school, but in other research and development laboratories, hospitals, and veterinary practices.

Conclusion

The rules governing the 31st International Science and Engineering Fair were carefully prepared to allow for challenging motivation to students to explore the excitement of research in the biological sciences. They have been written to emphasize the responsibility of the student to employ humane methods under appropriate supervision. Further restrictions are not in the best interest of the public in terms of educational motivation, career development, and ultimate public service.

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Humaneness Supersedes Curiosity

F. Barbara Orlans

Abstract

Ethical considerations need to be addressed with respect to educational use of animals. Society extends greater latitude in what is permissible to do to an animal in the name of science to a professional research worker than to a high school student. A balance needs to be made of the significance of the expected experimental results, on the one hand, with the ethical costs, (in terms of pain or death to the animal), on the other. A reasonable boundary can be drawn, based on ethical as well as on practical considerations, to exclude invasive procedures on vertebrate animals in high school student work. The view is presented that such procedures should only be conducted in research institutions and should not be conducted in students' homes or in elementary or secondary schools. The rational basis for this stance is discussed.

Enhancement of secondary school biology education with classroom maintenance and study of a wide range of species of plants, invertebrate and vertebrate animals is needed. However, progress in this direction is dependent upon establishing sound policies on the educational use of animals based on considerations of social accountability. Current lax standards in science fairs have resulted in animal abuse and this has hampered progress in this direction. Encouragement to teachers and students to study living things must go hand in hand with proper observance of humane considerations.

Introduction

Are there limits to what should be done to animals in the name of biology education? Is any treatment to animals all right so long as the student is learning something? If not, then what are reasonable boundaries and what is the rational basis for them? Are current practices regarding the use of animals in science fair projects acceptable? What new directions are needed to maintain high standards? These are the questions that will be addressed in this presentation.

There is, I believe, a general consensus that there are very definite limits to what should be done to animals in the name of science. Henry Beecher, a renowned physician at Harvard University has spoken most aptly by stating that in scientific investigations "humane considerations supersede curiosity" (Beecher, 1968).

It is not a desirable objective, as an end in itself, to inflict pain on animals. It seems reasonable to me that, wherever possible, it should be avoided. Dr. W. Lane-Petter of the Huntingdon Research Centre advises research scientists to be "reluctant" in animal experimentation, reluctant to experiment on any animals in the first place, and reluctant to inflict pain. As a practicing physiologist accustomed to using animals

in experimentation, I believe that only as a last resort, when all other means toward the same goal have been investigated and found wanting, should animal experimentation involving animal pain be undertaken.

Limits to what should be done to animals are observed by professional scientists. Voluntary codes of practice and laws set limits to ensure public accountability. Acceptable boundaries entail the replacement of animals with other less sentient forms of life wherever feasible; the avoidance of any pain infliction wherever possible; reduction in the amount of pain wherever possible; and refinement of techniques to utilize the least possible number of animals.

Ethical Costs

On occasion, scientific experimentation includes a certain amount of ethical costs. Some examples of ethical costs are inflicting pain on animals, killing animals, placing human beings at risk, and use of lying and deception. These practices are basically undesirable, but they may be permissible in scientific experimentation in certain circumstances. However, they require scrupulous justification.

A balance is weighed between the ethical costs on one hand and the significance of the expected scientific results on the other. Where there is great significance in expected results, then relatively higher ethical costs may be justifiable. Where the results are of lesser consequence or trivial in nature, then there is less, or no justification for ethical costs.

Where there is potentially great significance to mankind involving new contributions to scientific knowledge, then, I believe, it is justifiable to permit infliction of pain on animals.

At the other end of the scale from a professional scientist, is a beginning biology student. Obviously, the significance of a high school student's experimental results is highly circumscribed. Thus, ethical costs should be kept low. Applying the principle of reluctance to inflict pain on animals, are there alternative ways, other than by inflicting pain on animals, for young students to learn basic biological principles? I strongly believe that there are. This leads then to the conclusion that high school projects should not involve harming vertebrate animals or interfering with an animal's health in any way.

Animals in Education and Research

There are many important differences between high school student biology projects and professional scientific research. These are summarized in Table 1. Unfortunately these differences are not always clearly defined and kept in mind. In the first place, the objectives of the work are completely different in the two situations. The professional scientist is attempting to make new, original contributions to scientific knowledge, whereas the high school student is attempting to learn an established fact. Mankind may benefit from the results of professional scientific research where, for instance, a new therapy for treating heart disease may be established; such profound benefits do not accrue from high school student projects. With professional scientific research, the significance of the results can be so great that a very large population can be affected by the results. For instance, the results could benefit many patients in a hospital, or a whole community or nation. With high school student work, potential benefits accrue to only a narrow few, perhaps to the student alone.

TABLE 1: Differences in Use of Animals

Differences	In Education	In Research
Objectives	Learn established facts	Acquire new knowledge
Significance of results	Limited	Up to profound
Benefits accrue to:	An individual	A wide universe
Technical ability	Early stage	Skilled
Location	Home or classroom	Research laboratory
Equipment and facilities	Frequently minimal	Up to optimal

Practical Considerations

In addition to ethical factors, practical factors also need to be weighed in assessing the justification for infliction of pain on animals. Limitations in technical skill alone can render some procedures (such as animal surgery) an improper activity for the unsupervised amateur. A comprehension and manual dexterity in the skills required for the procedure are all necessary prerequisites for undertaking invasive, potentially painful techniques. These skills are not instantly acquired, but are painstakingly achieved after many years of long training.

The quality of animal care and the humaneness of certain procedures is also dependent, in a certain measure, on the quality and type of facilities and equipment available. Thus, the location of where the work is conducted is important in determining what type of procedures should be undertaken. Equipment and facility limitations alone can render some procedures, especially those involving invasive animal techniques, either impractical or inhumane or both. High school classrooms are not usually suitably equipped for conducting invasive vertebrate animal procedures. How much less so is a student's home which is the location where very many science fair projects are undertaken?

Thus, there are clear distinctions between animals used in education and those used in research. These distinctions are all factors that need to be weighed in justifying whether or not vertebrate animals' pain should be sanctioned in high school student projects. The conclusion, I believe, is clear and can be summarized as follows:

Animals Used in Education	Animals Used in Research
• Pain to vertebrates NOT permitted	• Pain to vertebrates permitted under certain circumstances

This so-called "painless rule" for student animal investigations states that in elementary and secondary school biology education, the study of plants, protozoa, invertebrate animals and other living organisms including human and other mammalian studies shall be fostered and that vertebrate animal studies shall not include invasive procedures. In practice, this means that, as a general rule, small mammalian studies shall include only those procedures that could be done without pain or hazard to human beings and that the student would undertake on her or himself.

A Wealth of Projects

There are some unimaginative people who think that if you eliminate pain-inflicting projects, there aren't any others left to do! Obviously, this is false. There are multitudes of sound educational projects involving the use of living organisms that can be undertaken within the previews of the "painless rule".

In the first place, there are many plant studies that make excellent student projects. Such studies can cover genetics, germination, effect of hormones, light, heat and other environmental factors on growth and maturation, the ability of vines to grow toward a nearby object, studies of crown gall and other plant diseases, observations of the food chain, the use of leaves and other plant parts as insect homes, and investigations of the interdependence of plants with other living organisms, and other topics. An example of a good plant study is seen in Figure 1.

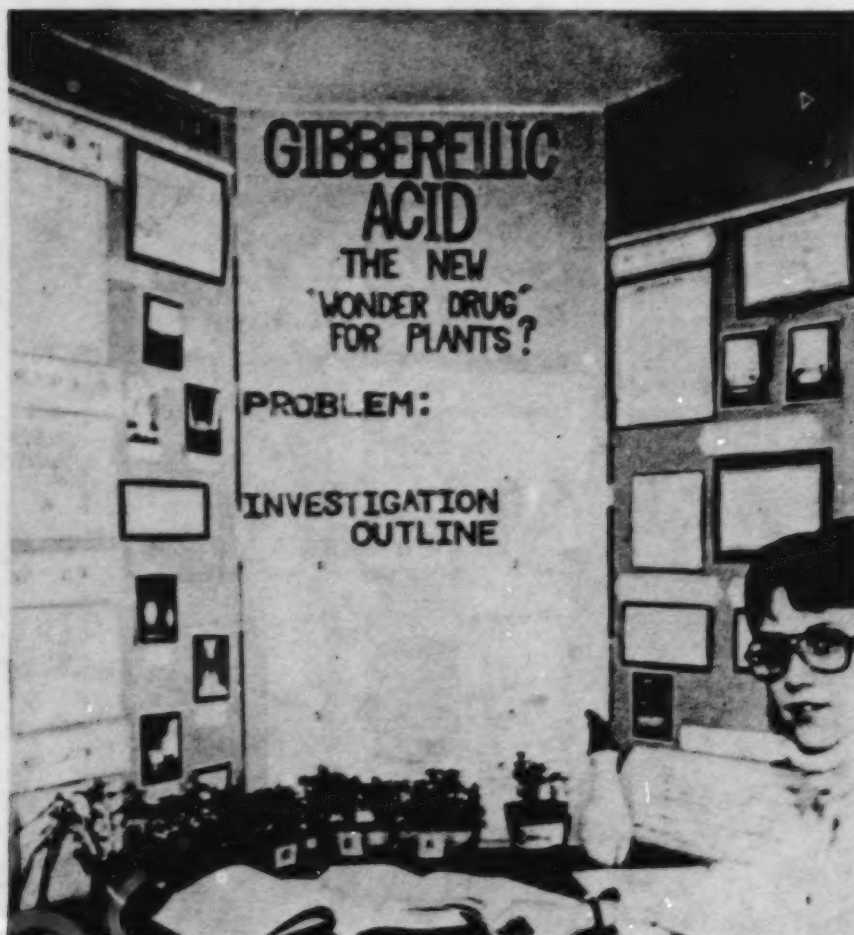


FIGURE 1—This biological investigation is of the effects of a hormone called gibberellic acid on plant growth. This is one of many interesting plant studies that can be pursued by high school students.

A similar long list of suggested projects could be made involving the use of fungi, nonharmful bacteria, protozoa and invertebrate animals. Such studies could include, but are not limited to investigations of effect of temperature on growth, sensory perception, activity cycles, water balance, ability to regenerate, behavior, nutritional requirements, environmental preferences, genetics, pheromones, growth, reproduction, learning, locomotion, field studies and control of insect pests. An example is seen in Figure 2.

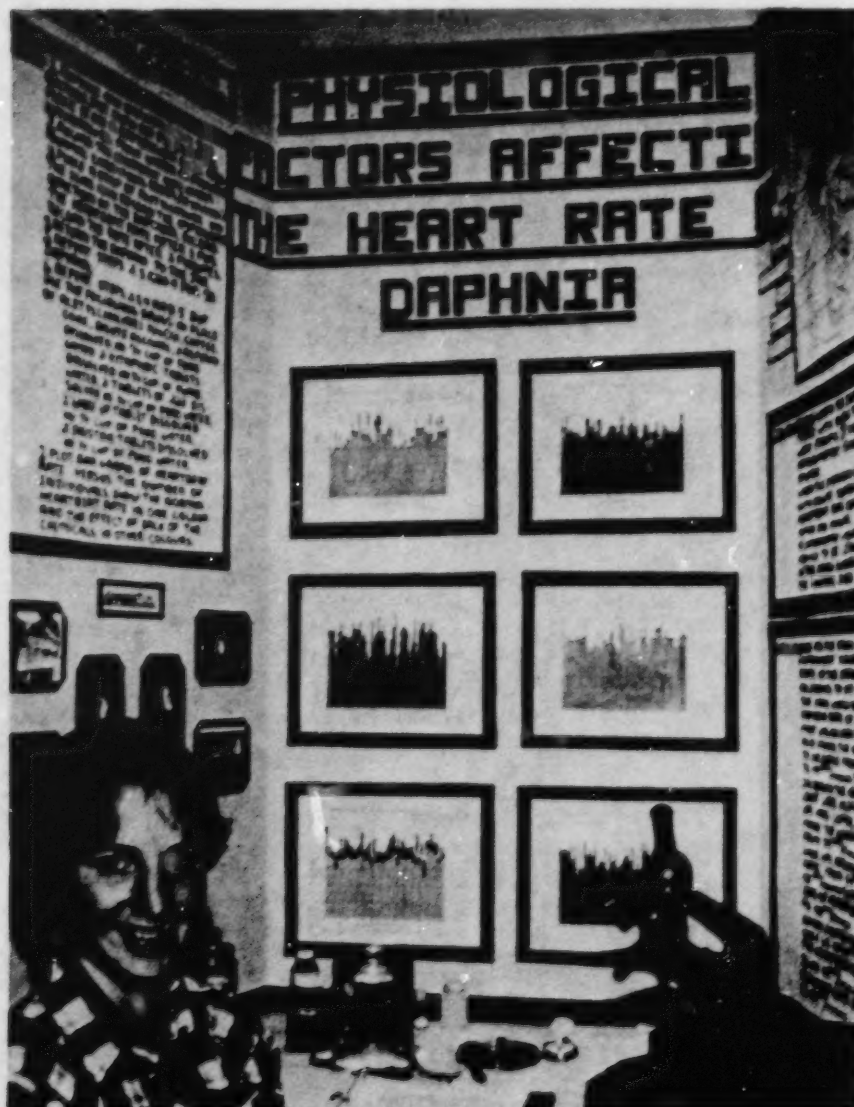


FIGURE 2—The physiological factors affecting the heart rate of small aquatic organisms called daphnia were investigated in this good project from a Canadian science fair.

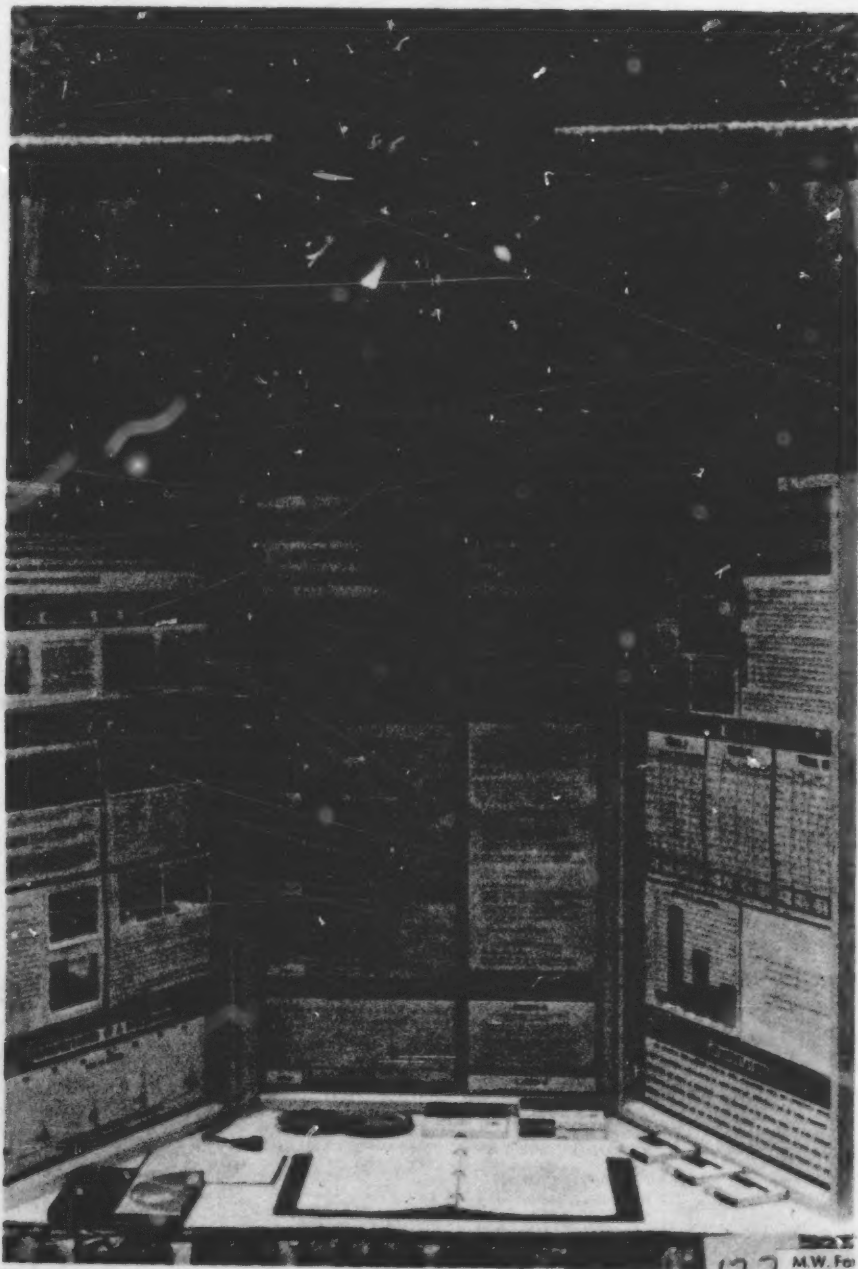


FIGURE 3—This project, which is an example of a nonpainful vertebrate animal study, dealt with vocalizations of the greenfrog. The inventive student recorded frog sounds in the wild and then analyzed the sounds by means of a spectrogram. This gives a visual picture of the patterns of sounds according to the frequency of the soundwaves. Some of the student's spectrogram tracings can be seen in the center and lower left of this science fair display.

Ideas for nonpainful projects on vertebrate animals are also many and varied and cover all the basic biological principles of living matter. Vertebrate animals include fish, amphibia, reptiles, turtles, lizards, small mammals and human beings. Non-painful, nonhazardous, educational projects on one or the other of these vertebrate animals can include investigations of schooling behavior of fish, group behavior, social structures, genetics, learning, field studies, excretory systems, respiration, growth and development, alarm reaction, locomotion, activity cycles, properties of skin and hair, sex ratio in a population, special senses (touch, hearing, taste, smell and proprioceptive responses), blood circulation, pheromones, grooming behavior, reaction to novelty, nervous reflexes and conditioned responses. An example is seen in Figure 3.

Classification Based on Degree of Invasion to Animal

The rational basis for the "painless rule" can be elucidated by categorizing biological projects according to the degree of invasiveness of the experimental procedure to the potential experimental animal. Table 2 depicts such a classification. The categories range from number one in which the studies involve no use of living organism and in which the ethical costs are least, to number nine in which severe trauma to highly sentient animals is involved and ethical costs are high. Looking at things from

TABLE 2: Classification of Biological Studies According to Degree of Invasion to Animal†

- 1) No living organism involved (e.g., biochemical studies).
- 2) Studies involving plants, fungi, bacteria or protozoa.
- 3) Studies involving invertebrate animals (e.g., hydra, flatworms, roundworms, snails, crustacea, and insects).

VERTEBRATE ANIMALS (Categories 4 to 9)

- 4) Observation of normal living patterns of a pet, an agricultural animal, zoo animal or wild animal.
- 5) Painless vertebrate experiments.
- 6) Painless killing of a minimal number of animals to provide fresh tissues for study.
- 7) Invasive procedures conducted under anesthesia with no post-operative recovery and no return to consciousness.
- 8) Pain-inflicting experiments (e.g., surgery with post-operative recovery, administration of toxic substances, induction of pathological conditions, stress studies, etc.).
- 9) Severe and/or protracted pain (e.g., severe deprivation, burn trauma, etc.).

†This classification is adapted from one given in Professor D.H. Smyth's *Alternatives to Animal Experiments*, 1978, Scolar Press, London, U.K.

the point of view of a potential laboratory animal or other sentient being, the procedures most preferred are obviously those in the lowest numbered category! From an ethical viewpoint, all other things being equal, the lowest possible category should be selected that is commensurate with the objective and significance of the exercise. Sometimes the ethical costs can be reduced by careful planning of an experiment or by actual redesign of an experiment. However, in order to achieve balance in educational projects, it is highly desirable that studies falling within each of the categories 1-6 be pursued.

Projects that are suitable for high school student investigations are those which fall in categories 1 through 6. Work within these categories is, of course, frequently performed by professional scientists. The cut-off point for students is indicated in the figure with a dotted line.

For the reasons given earlier, those projects which fall below the dotted line, categories 7 through 9, should only be conducted in established research institutions. All categories 1 through 9 are appropriate and I believe should be available to professional research workers to select from according to the nature of the investigation.

Some comment is perhaps appropriate regarding category 7 in which invasive procedures are conducted under anesthesia. The experiment may proceed for up to a number of hours, but then the animal is painlessly killed without being permitted to recover consciousness. Such procedures, if correctly performed, involve no pain other than the slight discomfort of induction of anesthesia. Unskilled, novice surgery would not cause the animal any suffering. However, in order to be painless, such studies require a sound knowledge of anesthesiology on the part of the operator in order to maintain the appropriate deep level of unconsciousness for prolonged periods of time. Because of the complexities involved and the need to use controlled drug substances, such studies are appropriate only if conducted in research institutions and in the presence of a supervising scientist knowledgeable in the technique. Such studies are appropriate for some undergraduate and graduate student exercises.

In their 1959 book, *The Principles of Humane Experimental Technique*, Russell and Burch elucidated their famous 3R dictums calling for "Reduction", "Refinement" and "Replacement." That is, that in animal experimentation, efforts should be made to reduce the number of animals used, to refine the techniques to minimize pain, and to replace animal experiments where possible with nonanimal experiments. Nowadays, there is much discussion about alternatives for animal experimentation. However, this centers almost exclusively on the "Replacement" theme. I believe much of the current emphasis is too narrow and constricting. Perhaps the idea of alternatives can be expanded to include a broader perspective. The classification offered in Table 2 based on ethical costs could be viewed in the light of all three concepts of reduction, refinement and replacement.

Classification Based on Degree of Sentience

Superimposed on this classification based on the degree of invasiveness to the animal, is another classification based on the degree of sentience of the organism (Table 3). The degree of complexity of the nervous system is a key factor in determining the ability of an organism to perceive pain. Thus, as we move up the phylogenetic scale, increasing ethical costs are incurred. As before, preference should be given where possible to using the lowest numbered category that is commensurate with the objectives of the investigation, thus incurring the least ethical costs.

TABLE 3: Classification of Biological Studies According to Degree of Sentience

- 1) Plants
 - 2) Protozoa
 - 3) Invertebrate animals
 - 4) Cold-blooded vertebrates (fish, amphibians, reptiles)
 - 5) Warm-blooded vertebrates (birds, mammals)
 - 6) Primates and marine mammals
-

Are Current Practices Acceptable?

There appears to be a general consensus among the participants at this symposium that animal abuse is rarely encountered in the classroom but is encountered in extracurricular projects such as science fairs. I share this view.

Current standards in most science fairs are unacceptable. There are some noteworthy and refreshing exceptions, but by and large, the standards for science fairs have followed the permissive, unsatisfactory practices of the International Science and Engineering Fair (ISEF). Every year, many improper animal projects are officially sanctioned and even rewarded by ISEF. For example, a prize-winning project in the 1977 ISEF involved a student amputating the tails and feet of lizards to show the already well-documented fact that tails regenerate and feet do not.

Two other improper projects are shown in Figures 4 and 5. These projects are in full compliance with ISEF rules. These three examples all fall within class 7 of the Table 2 classification based on degree of invasiveness to the animal. Thus, they are near to the top in terms of ethical costs and yet are being conducted by unskilled youngsters. Sometimes projects within class 8 (with highest ethical costs) are encountered in science fairs.

Obstacles

There are two major obstacles preventing establishment of satisfactory standards in science fairs. First, there is a problem of human behavior and misconceptions. All too many youngsters seem to think that it is highly desirable to undertake a project involving harming a small mammal; the second obstacle is the inadequate ISEF rules which tend to perpetuate unacceptable standards.

On the first point involving human behavior, it is a fact that a great number of students of their own volition choose to work on vertebrate animals in preference to invertebrates, protozoa or plants, and furthermore, they choose to inflict harm on these vertebrate animals. These facts have been repeatedly documented by independent observers. There is a misconception, promoted I believe by some science fair officials, that projects involving animal harm are more "sophisticated," more glamorous, more akin to "real" science, and therefore more meritorious than nonharmful animal projects or those involving invertebrates or plants.

Despite the good science fair rule that "protista and other invertebrates are preferable for experiments involving animals," this is not enforced.

A study of three science fairs showed that of a total of 109 biology projects in which some kind of living organism was used, half (53) involved the use of vertebrate



FIGURE 4—A young student tried to induce hearing loss in her pet kitten for this prize-winning science fair project exhibited at the 1976 International Science and Engineering Fair.

M.W. Fox

HEALTH

Rats receiving the largest dose of caffeine (180 mg/kg) had poor health. Observable symptoms were: infected eyes, occasional diarrhea, restless sleep, staggered gait, little weight gain, pallor, and breathing difficulties. They generally seemed to be in a state of depression.



Rat which received large dose.

FIGURE 5—The deleterious effects of caffeine poisoning are clearly evident in this picture of a sick rat, which along with the catalogue of toxic symptoms listed above, were part of an exhibit at the 1976 International Science and Engineering Fair. Such needlessly repetitious projects demonstrating that well-known poisons do indeed produce toxic effects are a regular feature in many science fairs.

animals; a quarter (27) involved the use of invertebrate animals and the other quarter (31) involved the use of plants and bacteria (Orlans, 1972c).

In another study of eight science fairs, it was shown that of those projects in which only warm-blooded animals were used (89), two thirds (58) involved infliction of pain or lingering death and only a third (30) were noninjurious (Orlans, 1972a).

Science fair judge, Dr. James R. Nazzaro (1972), reporting on the 1972 ISEF, encountered a similar overemphasis on pain-inflicting projects. He states,

Fully one half of the students with entries in the behavioral science category worked with vertebrates in their projects, and all of these used aversive stimuli, environmental stress, or brain electrode implantation, with eventual animal sacrifice. The majority of entries under medicine also involved vertebrates and over half of these employed aversive stimuli.

Data from a study presented by Dr. Dorothy Tennov earlier in this symposium demonstrated that a majority of undergraduate psychology students elected to undertake projects involving harming small mammals.

Young students are constantly being rewarded for conducting pain-inflicting vertebrate animal projects. A survey showed that a high school student's chance of winning a prize in a science fair for conducting a project in which mammals are harmed or painfully killed is one in three. Thus, of 58 pain-inflicting projects, 21 received prizes (Orlans, 1972b). This very high frequency of reward, unfortunately, leads people to believe that such projects are not only acceptable but somehow particularly meritorious.

Another major problem is the rules governing animal use in many science fairs.

The ISEF rules specifically sanction vertebrate animal surgery and other invasive procedures including administration of toxic substances, nutritional deprivation studies, use of cancer-producing agents, and production of pathological lesions and exposure to stress. The rules state that projects should be supervised. These rules have failed to achieve acceptable standards. There are a number of reasons why this is so.

A. The rules do not set a clear limit on pain infliction. It is difficult, if not impossible to comprehend what boundaries ISEF is trying to establish regarding what can be done to an animal.

B. Supervision does not act as a satisfactory limiting factor in determining what should or should not be done to animals. Many projects are not supervised, and some are only cursorily supervised. Furthermore, even if they are supervised, that still does not guarantee that projects are humane. Sole reliance on supervision has formed the basic concept of ISEF rules for about 15 years. During the time a vast accumulation of evidence has shown that reliance of supervision does not work. A basic change in concept is required.

C. The rules are not addressed to the majority of students but focus on an elitist few. In attempting to attract the "sophisticated" student, they have missed out on providing sound guidance to the vast majority.

D. The rules are complex and difficult to understand. They consist of 9 pages of forms and approximately 7 pages of printed instructions. This complexity reduces their effectiveness.

E. The rules do not make provision for differences in suitability of project according to the location where the work is conducted. In a 1972 survey, it was found that 80 percent of science fair projects were conducted in students' homes, and the rest in schools or research institutions (Orlans, 1972b). Experience shows that it is almost impossible to exert effective control over projects conducted in homes because here, supervision is frequently absent or cursory. It is unrealistic not to address this important factor of location.

F. The rules specifically mention that projects involving animal surgery, use of toxic and cancer-producing substances, exposure to stress and nutritional deprivation are officially sanctioned and do not mention any other suggestions of noninvasive vertebrate projects or invertebrate or plant studies. This tends to draw attention to the invasive studies and may lead students to do them.

In view of the record of the U.S. science fair movement and the deficiencies of some current policies, it appears that radical changes in the International Science and Engineering Fair are needed if they are to achieve public accountability. Many scientists and leading educators who are here today have deplored the absence of living organisms in the classroom study of biology and yet we have an overabundance of invasive vertebrate studies in extracurricular projects. Thus, we have two dual and opposing needs. One is to encourage study of living organisms in the classroom and the other is to curb improper animal practices in science fairs. I believe we need to have separ-

ate approaches to accommodate these two separate needs. For this reason, I endorse the Canadian national policies which provide one set of rules for the classroom (CCAC, 1975), which limit student projects to classifications 1-6 in Table 2, as discussed above, and other rules for science fairs. These "Regulations for Animal Experimentation in Science Fairs" (YSF, 1975), have been described in detail by Dr. Harry Rowsell in another part of this proceedings.

Future Prospects

It will require effort to effect changes in human behavior and attitudes to overcome the obstacles outlined above. However, there are a number of welcome signs that indicate that this will be achieved. Activity among professional organizations voluntarily to adopt student codes of practice based on the "painless rule" is encouraging. Such actions would have a profound effect on uniting opinion and would be highly beneficial in influencing current attitudes and practices. A readily comprehensible, national code of practice would then be in place which focuses on the majority of students. Bright students would continue to be encouraged to work as part of a team with professional scientists in research institutions. Widespread adoption of such a code would, I believe, be a most positive step toward achieving increased study of live organisms in biology education.

Over recent years, there has been a notable increase in awareness among teachers and policy-makers of the need to encourage use of living organisms in the classroom and the need to promote humane standards. Sound information on methods of care of animals and maintenance of invertebrates and plants are becoming available.* The professional societies are beginning to see the need for written materials, workshops and increased teacher-training on the care of living organism and selection of appropriate educational projects.

The dual needs in the biology classroom to study living organisms and to be sensitive to ethical concerns regarding animals can go hand in hand. The current climate is very positive and overwhelmingly in accord with the thesis that "humane considerations supersede curiosity."

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Role of the Student's Supervisor/Advisor In Science Fair Projects

F.M. Loew

Students undertaking projects for science fair competitions are required to have an advisor. This is to increase the likelihood that a project is developed which is scientifically sound, a learning experience for the student, and within the capabilities of the student. In the case of projects involving the use of live animals, the advisor's role is of great importance not only in ensuring the above, but also in preventing painful or stressful experiences by the animal(s) involved. Too often, supervisors have failed to genuinely supervise such projects, and as a result, animal use in science fairs is being increasingly curtailed. True supervision should entail the proper use of a literature review, a plan (protocol), and expert knowledge of the biology and care of the animal species concerned.

The student's supervisor or advisor must really assume absolute responsibility for the appropriateness of the techniques selected and the acquisition, care, and disposition of any animals used. Most of the reported irregularities in animal use by science fair competitors could have been prevented by supervisors who really examined the plans and execution of experiments.

The science fair networks, so potentially useful in education, must create rigorous procedures for advising and supervising animal projects. If this cannot be done, then certain types of animal projects ought not to be carried out.

Fundamental Criteria for Determining the Educational Value of Live Animal Experimentation in High School Science Fairs

David H. Neil

Abstract

The author contends that great and very detailed attention to one minuscule facet of experimental animal biology, particularly if it requires the skilled and uniform alteration of a significant number of animals, is of no real educational value to a high school student. This type of work, the necessity for it, and the full understanding of its significance to the furtherance of human understanding must be the province only of those who are intellectually prepared. The suggestion is made that projects, which develop a more complete understanding of common and profoundly important elements in life (as we know it), should comprise the first steps for the aspiring bioscientist. Unfortunately, this is by no means a universal point of view, and educational programs still tend to be prematurely piecemeal and fragmented. The author concludes the presentation with examples of animal experimentation which might well serve as a catalyst to a sound understanding of biology where life is perceived as a fully integrated process.

Introduction

It might be contended by some that I ought to be in a torment of ambivalence on this issue, and when I glance over the last decade I can see why. During that period I have been happily involved in teaching people about animals. For three years in the early seventies I was a science fair judge in the Biology division of the Ottawa Regional Science Fair in Ontario, Canada, and I also served on the Animal Care Committee of the Canadian Youth Science Foundation. Last year I was invited onto the board of the Longs Peak Science Foundation in Colorado, which operates our local high school Science Fair. Throughout the last sixteen years, I have been a practicing laboratory animal veterinarian with ultimate responsibility for the care of countless numbers of laboratory animals in four major research institutions in three countries. In many instances I have been directly responsible for deliberately interfering with the health of these animals by the administration of noxious agents of one sort or another, or by surgical intervention.

My principal extracurricular pursuit since 1977 has been an active commitment to

our county humane society, which in addition to its shelter activities gives classes in our school system on animals, pets and people. To the observer perceptually accustomed to the polarization of "Vivisectionist Scientists" (guileless or otherwise) on the one hand, and the 'Humanic Antivivisectionist' on the other, I might be expected to have within me levels of ideological friction far beyond the tolerable limits of the most phlegmatic thinker. Nothing could be further from the truth and I would venture to suggest, in all humility, that others might do well to openmindedly try the same dialectical approach to the attainment of acceptable compromise within their own minds (*veritas in medio stat*).

Interventional Studies on Animals

From the outset let me say that I believe that research involving the use of laboratory animals is necessary for maintaining and improving the quality of life for man. To be more general, let me say that I believe that man's "graspingness-of-mind," as much as it gets him into trouble with the world in which he lives (sometimes to the point of mortal danger) is nevertheless part of his *raison d'être*.

Man's graspingness-of-mind is as necessary to his survival as speed is to the antelope, and tooth, claw and stealth are to the tiger. I firmly believe that man must now address not only his own new and unsolved problems, but those problems arising from some of his earlier crude and clearly imperfect solutions. We cannot go backwards. Attempting to attain a safer more manageable world by retrogression is an exercise in illusory nostalgia without historical support.

Biomedical research is an integral part of this "graspingness-of-mind," and the use of animals in research is a necessary part of this at present. I am committed, therefore, to the use of animals in biomedical research when there is a significant chance of improving or safeguarding our quality of life. Nevertheless, I look forward to the day when we may achieve all that is needed in this regard for our continued success as a species, without having to violate the creatures with whom we share the earth. To me that era would symbolize the evolution of a greater intelligence in hominids, perhaps deserving of the name *Homo omnisapien*.

I am one of many thousands of a like mind. The department of public affairs of Hoffman-La Roche in No. 12 of a series on public issues, *Animal Experimentation in the Pharmaceutical Industry*, states "Scientists and lay persons alike look forward to the day when reliable alternatives can replace animal experimentation in medical research. That day, however, is still far in the future. Meanwhile, serious health problems continue to exist. Scientists must continue to rely on laboratory animals for much of the knowledge needed to solve these problems." And so they do, but more and more and in the main they do so with great care.

This has been a memorable year in this regard. The National Institutes of Health adopted a new *Guide for the Care and Use of Laboratory Animals* prepared by the Institute for Laboratory Animal Resources (1978) of the National Research Council. They also introduced new contractual obligations for contractors and grantees at the individual institutional level. (*NIH Guide for Grants and Contracts* Vol. 7, No. 17, Nov. 10, 1978.) Among the mandatory requirements was the need for a knowledgeable five person animal care committee (credentials of individual members being filed in Washington D.C. with the Office for the Protection from Research Risk, N.I.H.). These committees are charged to "maintain oversight of its (their) animal facilities and procedures." In the same document are listed: "Principles for Use of Animals" which are also

published again in Appendix V of *The Guide*. I feel that these are so important to the consideration of all interventional animal studies* that I should like to quote some of them here.

The Research

3. The research should be such as to yield fruitful results for the good of society and not random or unnecessary in nature.

4. The experiment should be based on knowledge of the disease or problem under study and so designed that the anticipated results will justify its performance.

5. Statistical analysis, mathematical models or in vitro biological systems should be used when appropriate to complement animal experiments and to reduce numbers of animals used.

6. The experiment should be conducted so as to avoid all unnecessary suffering and injury to the animals.

7. The scientist in charge of the experiment must be prepared to terminate it whenever he believes that its continuation may result in unnecessary injury or suffering to the animals.

8. If the experiment or procedure is likely to cause greater discomfort than that attending anesthetization, the animals must first be rendered incapable of perceiving pain and be maintained in that condition until the experiment or procedure is ended. The only exception to this guideline should be in those cases where the anesthetization would defeat the purpose of the experiment and data cannot be obtained by any other humane procedure. Such procedures must be carefully supervised by the principal investigator or other qualified senior scientist.

9. Post-experiment care of animals must be such as to minimize discomfort and the consequences of any disability resulting from the experiment in accordance with acceptable practices in veterinary medicine.

10. If it is necessary to kill an experimental animal, the animal must be killed in a humane manner; i.e., in such a way as to ensure immediate death in accordance with procedures approved by an institutional committee. No animal shall be discarded until after it is dead.

This is the statement of our contemporary ethics in the scientific community regarding the use of animals in research. Perhaps it did not use to be. Certainly Russell and Burch (1959) in urging their three 'Rs,' "Replacement, Reduction and Refinement," twenty years ago, were crystallizing the desires of many, but certainly not the mainstream of opinion in the bioscience community at that time. But it is apparent to me that ethics change as society changes, and many societal changes have occurred in the last two decades. Some of those changes have had high and wide visibility, such as the achievement of the moral and well as the constitutional rights of black Americans, and the revolution of sexual mores. Both the foregoing examples are very dramatic, and yet

*By interventional animal studies I mean those in which an attempt is made to induce a change in the animal such that its physical and/or mental wellbeing would be compromised, and as a result it can no longer be regarded as within the range of a normal state of health (e.g., those things resulting from surgical alteration, aversive stimuli leading to abnormal behavior, the feeding of nutritionally deficient diets and the administration of toxins or etiologic agents of disease).

I would contend that although the use of animals in research is largely a concern of specialist groups in more discrete numbers, the changes in attitude of experimental animal users and the degree of attention given to laboratory animal usage and care which have occurred in the same period of time are equally dramatic.

Clearly the mainstream of moral thinking in the biomedical sciences in 1979 is not ambivalent in regard to the use of experimental animals. There is a dynamic equilibrium between the desire of man to live well and the concomitant use of animals for research on the one hand and the respect for life and the proper care of these animals on the other side of the equation.

In concluding my first point I will pose the following questions, and leave them for you to answer. If the biomedical and bioscience researchers are striving to minimize the use of animals, and if they have established safeguards for the use and care of animals in research situations, and if they have stated that the ultimate goal would be not to have to use animals in this way, then how can we not apply the same standards or criteria to the citizens and scientists of tomorrow? If we condone interventional experiments or technical demonstrations on laboratory animals in high school science fairs, are we not establishing a double standard? What justification for performing interventional experiments at this stage of a young person's biology education can there be? Even if one could justify interventional experiments, could one guarantee the same standards of care, from personnel highly trained in this work at all levels? Could there be adequate peer review of project proposals? I believe that the advocates of interventional experiments in high school science fair projects might be a little less adamant after making a serious attempt to answer these questions honestly.

In my experience with university students with high school still fresh in their minds, I find that year by year they are increasingly more aware of the need to think very carefully about such issues. We are experiencing a shift from amorality to moral concern. A number of these young people have referred with disdain to their traumatic and insensitive introduction to vertebrate biology in school laboratory situations. There is no doubt that using animals in teaching is a more delicate issue than using them in research, because it is compounded by the effect upon the student over and above the consideration of the animals themselves. Desensitizing and inuring students to procedures likely to produce distress in animals does not serve them well and quite clearly this has occurred in the past, particularly in science fair situations. More important though, because they are probably far more common and insidiously subtle, are those procedures which cause little or no distress to the subjects, but alarm and brutalize the neophyte, such as the more physically violent (albeit controlled) methods of causing sudden death or insentience, such as stunning, cervical dislocation, decapitation and pithing.

Thus far, therefore, we may postulate that interventional animal experimentation in high school science fairs might strike the bright and informed student of the 1980's as follows:

A. A double standard exists concerning the use of animals in science. One stringent and moral set of standards for the fully fledged, bona fide bioscientist, and another amoral set of standards for animal use in high school science fairs.

B. Because science fair regulations and NIH guidelines are wholly incompatible with one another, and the continuance of interventional animal experimentation in science fair projects is permitted by officialdom, then our elders are posturing, and

their concerns are not sincere, but more motivated by politics. This has shades of the sixties cast all over it; another lever in the credibility gap.

C. In order to be a good biomedical scientist, or practising professional such as a doctor or a veterinarian, one must become inured to distress and be able to inflict pain and suffering without emotion.

D. Generally speaking morality is an adult thing, being a carefully argued facade of academic interest only but with considerable political utility for the skillfull pragmatist of the future.

We might consider at this point whether we would wish our children to be as we were, and to some extent still are, or would we rather they become what we would wish ourselves to be? Is education the process of maintaining the status quo, or is it part of the movement to a better future for mankind?

Educational Value of Interventional Experiments

If we assume hypothetically that equivalent standards of environment and ethics for the care and use of animals in research institutions could be applied in high school situations, then this would overcome many of the objections I have raised so far. The question of the educational value of interventional experiments with animals in high school science fairs remains to be addressed, however, and I have some thoughts on this subject.

Although I am sure all of us agree that it is very unlikely, though not impossible, that a high school biology student is going to bring about a major conceptual change, or even a significant advancement in the "puzzle solving" of the "tradition bound activity of normal science" as Kuhn (1970) referred to it, I nevertheless think that a high school biology project in a science fair can demonstrate an established fact or principle with elegance and clarity.

There is even one area in which the diligent neophyte observer of life can perhaps make an original observation. I refer to the study of normal animal behavior. The patient and tutored observer can make original observations, and I encountered such a happy instance in Ontario, Canada in the early nineteen seventies where a young man had conducted an ethological field study of the fisher (*Martes pennanti*) in winter. It is not the possibility of originality, however, that makes the study of normal animal behavior so exciting to me but rather the idea of studying the entire animal and its environmental relationships initially rather than starting with a mammalian cell and then approaching the whole animal through a variety of organs and systems, in a morass of data which to the majority may seem to be fragmented and not immediately relevant to an understanding of the entire organism. Perhaps the biology student is expected to commit all the fragments of information to memory for subsequent recall when animal ethology is finally broached. This in my own case occurred many years later.

I do not believe that the high school biology student has the degree of knowledge or understanding necessary to benefit from interventional animal experiments because this type of work inevitably is focussing on one small facet of the animal's biology, and frequently is associated with resultant abnormality. The student cannot know normality well enough to appreciate the abnormal, nor can detailed and fragmented study assist at this stage in a full appreciation of the healthy animal in one piece.

Since it is clear by now that I have developed a great sensitivity to man's use of animals, I would like to give an inanimate and unemotional example of what I mean by "fragmentation" in science education.

If one wished to develop a concept in a student's mind of the physics and engineering of flight and our contemporary use of these principles, how would one go about it? By studying the engine pylons of a DC10; by studying the metallurgical properties of magnesium/aluminum alloys; or by disassembling an RB200 jet engine? They are all part and parcel of modern flight but are all special technologies. When one has finished, one may run home and tell Mom and Dad what fun one has had, but the basic concept of human flight and how it is achieved has eluded one completely. Such isolated exposures would be little more than seemingly unrelated *techne in vacuo*. How many biology projects are like this, however?

A trip in a Lockheed Tristar and observation of take-off and landing at once embrace the principles of flight, and to the inquiring mind are inspiring of awe and motivating to the acquisition of more knowledge. What appears to be a simple up and down procedure on a grand scale, clearly relies on many complex systems within and outside the aircraft, and the questions will tumble out of the young observer's mind. The answers (where they exist) will be used to fill in the myriad of gaps, but they will always be relevant to the whole aircraft, and the joy of enlightenment can have its full motivating effect, because it is in answer to the questions which the young mind feels are relevant to an understanding of how a Tristar goes up and down.

We must remember that human flight to the aeronautical engineer is not quite the phenomenon that it is to each person contemplating it specifically for the first time. The bright young mind may be triggered into asking those questions which men have tried to answer since Leonardo da Vinci and before, the basic difference being that many of the questions now have readily available answers. Therefore, I will pose another question for you to consider. Why not lead young aspiring scientists along the historical pathways of human inquiry, rather than down the narrow tunnels of *techne*?

So many of our science fair projects in the past have been isolated examples of *techne* and not of science. Merely imitating the techniques used by scientists in their pursuit of knowledge may result in the student developing a very incomplete and unbalanced view of science and scientists. There is no doubt that scientists have fun in their pursuit of knowledge, but the fun is intellectual and not mechanical. The mechanics or *techne* of investigation serves the search for knowledge and is an integral part of the scientific method. It is not, however, the whole thing nor is it necessarily the lion's share.

If science fairs are to have any real meaning, the motivation to enter must be for the right reasons; it must be to know what science is and to understand the scientific method in pursuit of a concept.

I do not believe that it was a burning desire to grow peas that consumed Gregor Johann Mendel. It was the question of what determined the characteristics of progeny in sexual reproduction. The concept on which he based his experiments is thought by Bronowski (1973) to have been the inheritance of sex (after all, one either ends up with a male or a female and not an hermaphrodite). It was human genius; elegant simplicity so obvious everyone overlooked it. The motivation was "the question;" the excitement was the concept; the anticipation was the experiment; and the ecstasy was the knowledge. The motivation was not a trowel and a packet or two of seeds!

We must not debase science in the minds of the public, the citizens of tomorrow, or ourselves by allowing mindless *techne* to pass as science in itself. Such a popular

attitude does exist today to some extent and has served science and therefore all of us rather badly in recent years. If we are to have high school science fairs then let them be about science in the biology division also. But if the fairs are to include an amateur surgeon's division, then rename either the division or the fair and do not burden science with such absurdity.

Selection of Animals and Projects for Science Fairs

I would now like to discuss the sort of animals I would like to see used in science fairs and the type of studies involved. Why the mammal (rat, mouse, gerbil, etc.) is ripe for interventional experiments for boys and girls intrigues me. It must have something to do with their availability, but I think it also has been associated with their "complexity" and their "closeness" to us, at least compared with arthropods, for example. Obviously, the reasons are many, and it is also quite likely that a clear rationale for preference that can be substantiated has yet to be developed. Life in all its forms is amazing, and it is in some of the "lower forms" such as the arthropods that we now begin to realize, with some degree of awe, the complexity of the organism and the precise sensitivity of that organism to the many facets of its environment. In addition, such knowledge makes one realize the impossibility of manufacturing an "order" of sentience. While we boom out our lofty thoughts in spoken words, the earth beneath us, the water around, and the air about us is alive with orientating organisms, sensitively communicating with their kind and striving to cope and compete within their part of the biosphere without, one might add, threatening to destroy the whole shebang!

I do not believe that people in general realize the complexity and sheer wonder of life in all its forms, and that is quite likely one of the reasons why they abuse it so, or at least stand by and watch it be abused. Let it never be said that the education we provided did nothing to change that. May we never see the day when men might say their education encouraged or failed to prevent rapacious destruction of their own environment. Some of my colleagues believe that day to be already upon us.

How can we encourage man's awareness of himself as an integral part of the equilibrium of the biosphere, with the unique capability as a species, to be a responsible steward and thrive himself, like a latter day Noah? We must become more aware of the role we may now play in the continuance of life on earth as we know it. This is not only the province of a handful of concerned scientists, or even aspiring bioscientists, the many puzzle solvers of tomorrow's "traditional science" in its broadest sense, but it is also of profound importance to future politicians and industrialists. Therefore, above all else our teachers must now, if never before, speak of life and living and our role of stewardship.

The first encounter with a species surely must be with the live health organism in its fullest sense. The frog is often the first terrestrial vertebrate encountered in biology and unfortunately a good analogy to my earlier example of the fragmented study of an aircraft. The first encounter a city student might have with a frog is either in dissection or even with a live heart preparation. I have sought and received feedback from both arts and science majors on their perception of these experiences. The general feeling is one of failing to see the point of it and of being "freaked out" by the procedures. To me the greatest indictment of this type of teaching is that the students at the end of their course of instruction still know nothing about frogs, even though some of them will know something about the sino-atrial node.

Quite clearly, we need to reevaluate the way in which we organize the exposure

of the young mind to the study of life. It has already been suggested that the relatively new science of ethology is probably the prime candidate to greatly enhance good education in biology, and I must definitely concur, for not only does it give a true understanding of a species in dynamic equilibrium with the environment but it also emphasizes the complexity and sensitivity involved in this in the alleged "lower forms" of life.

Donald R. Griffin (1976), in his book *The Question of Animal Awareness*, starts out by stating that the book should not have been necessary because our increasing knowledge of animal behavior should have had a more profound effect on our thinking than it has. He discusses animal behavior with emphasis on evolutionary adaptation to the natural world; for example: social organization and communication; individual recognition; altruistic behavior; rhythm and biological clocks; and orientation and navigation. He states that:

... ethologists now feel confident in making statements that differ qualitatively from anything that was scientifically thinkable forty or fifty years ago. ... [and] it is especially appropriate to pose some new questions and to reopen certain old ones from a fresh perspective. Most of these questions relate to the general issue of our evolutionary kinship to other species of animals, with special reference to the more complex cognitive functions that appear to regulate the behavior of animals and men. ... Ethologists and comparative psychologists have discovered increasing complexities in animal behavior during the past few decades. ...

When I read this book, I found it difficult to stop. The part that aroused me the most was not the excitement over sign language in nonhuman primates but rather the complexity of communication and orientation in bees observed by Karl Von Frisch between 1923 and 1974. I heard the 'music' of the whirling, wiggling swanzel-tanz, and I have never been the same since; it is the bees' dance language or tanzsprache in which distance, direction and quantity of pollen or nectar are communicated by returning bees that I found truly amazing. As if my previous and long ignorance of this complex communication was not enough, I was incredulous at the description of the observation of several bees each, making their report, with an ultimate decision being made based on quantity and distance. The accuracy with which an experienced man can interpret tanzsprache is extraordinary, being 10 per cent plus or minus the real distance and 10° either side in direction. For the first time, I realized the incredible complexity and awareness of those "lower forms," and I was filled with wonder.

Perhaps the emphasis on the animal cell as the unit of animal life is unsound. Surely the unit of animal life is the animal itself. Surely the study of its life, its biology is the study of how that animal survives in its environment. Perhaps we should know what food an animal eats and how it acquires that food before we know how it digests it, and what happens when it cannot.

My friend and colleague, Dr. Bernard Rollin at Colorado State University, has adopted Aristotle's term "telos" in a book soon to be published. This is the expression of character that makes a field vole a field vole; it is the expression of the animal's individual and sometimes unique characteristics which can be clearly identified as typical of that species. The study of the organism and its telos is to all intents and purposes ethology. Griffin (1976) addresses the nature of ethology and shows it to be the expression of the animal which can nevertheless be broken down to basic components in the empirical sciences. He writes:

No one supposes for a moment that an animal's walking, running, swimming, and flying require more than the activities of muscle cells, connective tissue, and neurons; no immaterial 'essence of locomotion' is called for . . .

. . . the patterns of structural and functional coordination by which thousands of cells produce bird flight, for example, are not easily derived from data on the endoplasmic reticulum or sliding filaments of actomyosin.

Again, in referring to the immense complexity of bird flight, he says:

. . . this does not delude us into postulating vitalistic essences of flight independent of physics, chemistry, or cell biology.

Nevertheless, he argues that these disciplines only help us to understand the multitude of coordinated components of, say, locomotion or orientation. The sum total of all of these is a creature behaving in its environment in a way characteristic of its kind, like its fellow organisms now, then, and in the future. The creature's telos is very real and is vital to its success or failure, but the components can be broken down many times under the electron microscope and in the chromatograph etc. etc.

At this point, we have come full circle, back to the example of the Lockheed Tri-star aircraft used earlier in this presentation and in my opinion the same principle of science education applies. Thus, the appreciation of bird flight in its totality leads to many questions, and some answers. At no point is knowledge isolated in vacuo; on the contrary, it constantly enriches the overall understanding. Where gaps in our current knowledge are found by the student, he or she may then encounter current endeavors in scientific investigation, the puzzles of traditional science.

Conclusion

I do not believe that we can justify on moral or educational grounds the use of interventional experiments at the high school science fair level. Examples of interventional experiments encountered by some in the past and referred to at this meeting only serve to emphasize my point. I do believe, however, that biology education without live animals is largely a waste of time and effort.

The use of existing facilities such as zoological parks, particularly in the more highly populated areas, has already been discussed by others at this meeting. Animals in their association with man form a fascinating study. The urban dog or cat, whether happily domiciled or roaming ownerless, are an excellent focus for detailed observation. I believe family pets in general are much underrated as subjects for high school ethology. The value and the needs of pets in society could certainly stand the scrutiny of the citizens of tomorrow.

The rural high school student has a wealth of material ranging from the wild but less shy creatures such as ground hogs and prairie dogs, to the fully domesticated animals such as the horse and ox (*Bos taurus* and *Bos indicus*) family. If animals are to be kept in captivity in schools for whatever educational purposes, I would like to see them in vivaria, where their natural environment is simulated in units built by the students themselves under instruction. These projects may be more expensive and time consuming, but the cost-benefit ratio must be eloquent in support of this sort of endeavor. Thus, we could envision classroom beehives which have been available for

years with the lucite observation panels; aquaria which are excellent ecological models; and vivaria for gerbils, field voles and deer mice. Vivaria for amphibia and for harmless reptiles might also be considered.

It has taken me thirty years to reach my present state of awareness and I feel that I have only just begun. It is sad to have to admit that one's perception of the living world of which we are an integral part has been limited and impeded by a lack of knowledge unrelieved by a fairly extensive science education. I must reiterate that I believe that man's "graspingness-of-mind" is a major part of his *raison d'être*. Whether he continues to evolve or perish depends to a great extent on the concept he has of life on this planet, including his own. High school biology education is the starting point of our human understanding of the integration of life as a whole and our place within it. We must ensure that it speaks of the oneness of all life first and its amazing complexity second.

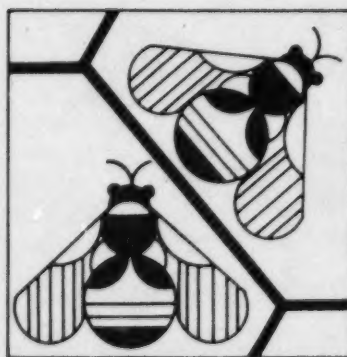
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DISCUSSION

The papers presented in this section were invited following the conference discussion and address state education legislation, educational practices, and the philosophies of animal rights.

CHAIRMAN: ANDREW N. ROWAN



Discussion Paper

A State Educational Agency's Position on Science Curricula Involving Animals

William E. Spooner

As a division of a State Educational Agency, we have a legal responsibility for the overall science curriculum. We are constantly striving to improve the quality of science instruction through efforts in staff development, curriculum and facility improvements, and communications. In our communications and publications, we strive to inform teachers of issues and trends. Recent emphasis has focused on laboratory safety and the use of live animals in science teaching. With respect to animals, it is our belief that the use of live animals can and should be a vital component of any modern science program. Research on current learning theory strongly supports animal use as a means of providing meaningful, concrete learning experiences for students at all grade levels. These experiences are essential if students are to fully comprehend basic life science concepts.

Historically speaking, science teachers have never received formal training in laboratory safety or animal care, which also encompasses humaneness. However, we find science teachers are very responsive to social issues and are willing to change outdated teaching methods when new social standards develop. Science teachers ask for facts on such issues. They want to examine, discuss, and interact on all aspects of the issue, both pro and con. They also look to their major professional organizations for guidance and help on sensitive matters. Teachers are more likely to change classroom methods if new concerns are presented in a positive and objective manner, and specific alternatives to these problems can be suggested. "Hands-on" workshop experiences with such alternatives are very helpful.

Several aspects of the current animal issue cause concern. Perhaps the first and most important is the lack of consensus between professional groups on one major point relating to appropriate use of animals in science teaching. This disagreement centers around the use of vertebrate animals in activities that cause pain or stress. Since major organizations such as NSTA, NABT, HSUS, AWI, CSSS, ISAP, ISEF, APA, NSMR, and others are close to agreement, then every effort should be made by these groups for coalescence on the issue. At this point, it seems reasonable to support the position that any activity involving significant manipulation of an animal or its environment should be conducted at a regular research facility or its equivalent as a part of an ongoing research project.

The second concern relates to guidelines on the use of animals in science teach-

ing. Guidelines, codes of conduct, or position statements are essential. They need to be as short and simple as possible if they are to be used and understood by teachers at all levels of science instruction. It may be true that very few "inhumane" science projects get to state or national levels of competition. This point is supported by an analysis of projects at an independent regional science fair in North Carolina this past year. Three hundred and fifty-one projects were entered. Ninety-seven were in the biological area; only 24 projects involved vertebrate animals. Of these, three projects were observed to be questionable with respect to the current humane issue. Three may not seem excessive, but these three could have been prevented if guidelines had been established by the sponsoring group.

A new interest and awakening in science on a national level further supports the need for such guidelines. In North Carolina, we are aware of a growing interest in science fairs and research projects. There are about 400,000 students taking science in the secondary schools of our state. In the junior high grades, only 53% of the science teachers are appropriately certified to teach science. When this is coupled with the science backgrounds of elementary teachers, who are by law required to teach science, the problem is compounded. The number of science fairs at the local school level is increasing. Many of these take place in individual classrooms. Others involve the whole school system. Both elementary and secondary students are involved. Theoretically, thousands of science fair projects could, and do, take place in isolation of any recognized regional, state, or national science fair. Do these low-level fairs involve animals? Are guidelines on the humane use of animals applicable to these projects? If the response is positive to these questions, then simple, easy-to-understand guidelines are essential.

Discussion Paper

Implications of State Humane Laws for Education

Wayne A. Moyer

We have recently seen a number of laws being written which are directed at teachers in public schools regarding use of animals in classrooms. In Illinois a seven-year-old law forbidding any experiment on any animal in a public school was resurrected as a result of a BSCS experiment involving testosterone injection into male chicks. This resulted in all animal experiments being halted in Illinois public schools. The Illinois House passed a bill which invoked the existing Animal Welfare Code. Strong opposition developed in the Senate and a compromise was worked out between the Illinois Association for Biology Teachers, the Illinois Science Teachers Association, and the American Humane Association (AHA). It was agreed that pithing of frogs, nutrition experiments, and cancer-induction experiments had no place in schools in Illinois. To cover nutrition experiments, a second section of the Animal Welfare Code was invoked; all animals shall be provided with proper feeding and water. George Zahrobsky, representing the teachers, agreed to write a letter to be published in the AHA newsletter setting forth the conditions for the compromise. However, when the bill reached the Senate floor, the hand shake agreement fell apart and strong opposition again developed preventing passage of the law and leaving the old law in place, thus preventing any animal experiments of any kind, including observation, in the public schools.

In Massachusetts a law was recently passed late in the legislative session which is again directed specifically at teachers. While less restricted than the Illinois laws, it effectively prevents chick development studies and animal husbandry studies, such as fish raising for food, in both schools and science fair projects.

I have a number of concerns: Who is to be arbiter of what is humane? I am concerned about any group which sets itself up as the sole authority on any topic. Secondly, I object, and will oppose, any special legislation which singles out the teachers and saddles them with regulations which do not apply to the society-at-large. We have existing animal welfare laws which should be used. Third, I am concerned about the drive to pass laws without first working out compromises at the professional level. The legislatures of the states are not equipped to handle these problems when they are presented from a unilateral standpoint. We all have similar aims, and we should work out acceptable guidelines outside of the political arena. Finally, I am concerned about the confrontation-style politics practiced by certain elements in the animal welfare lobby. Irrevocable positions and verbal overkill do not serve democracy well.

In 1966 Judge Charles S. Barrett of Essex County, New Jersey supported the right

of a teacher to judge the educational value of supervising student use of animals in an experiment in school. His concluding remarks are instructive: "SPCA further argues that the result, if defendant Board were successful, would be that the science teacher would determine when the experiment was justified, balancing his evaluation of the pain and cruelty against the educational value to be derived. This indeed would place an awesome responsibility in the hands of the teacher, but then again the minds of our children are also placed in his hands."

Discussion Paper

A Brief History of the 1979 Massachusetts Act Regulating the Use of Live Animals in Public School Activities

Nancy Ann Payton

In March 1894 the Massachusetts legislature, at the urging of the Massachusetts Society for the Prevention of Cruelty to Animals (MSPCA), enacted the first United States law prohibiting vivisection in public schools and restricting dissection to the classroom. The law remained unamended until the 1970s, when renewed interest in the use of live animals in pre-university educational activities brought the law once again to public attention.

The MSPCA was becoming increasingly concerned about science fair projects that used live animals. In response to inhumane experiments competing at the Massachusetts State Science Fair, the foremost science fair in the Commonwealth, the MSPCA and several other animal welfare societies approached representatives of the fair. As a result, in 1978 the Massachusetts State Science Fair adopted more stringent guidelines on the supervision of participants using live animals, e.g., proper care and handling were outlined in more detail. There was hope in the humane community that these guidelines would filter down to the regional, local and school science fairs striving to send finalists to the state competition.

To the dismay and disappointment of the MSPCA, the 1979 State Science Fair's enforcement of the new humane guidelines was nonexistent. Not only were projects more blatantly cruel than the previous year, but the judges failed to disqualify projects that clearly violated the guidelines. The formal request by the MSPCA to include a veterinarian and/or a humane representative on the 39-member State Science Fair Committee was completely ignored.

Reacting to cruelty which he had seen at science fairs, a Boston science teacher began introducing remedial legislation. The thrust of his bill was to limit science fair projects involving live animals to observational, noninterventive studies. The bill received little attention and repeatedly was killed early in the legislative process.

During the 1979 legislative session the bill was once again introduced by the teacher and was assigned to the Committee on Natural Resources and Agriculture. Although the April public hearing date was announced in early February, the MSPCA delayed active support of the bill until late April. This decision was due to continuing problems with the State Science Fair's obvious unwillingness to enforce even voluntary guidelines. It should be noted that the MSPCA has a definite policy of actively supporting legislation only as a last resort, when all other potentially expedient avenues have

been exhausted.

At the April hearing, the intent of the 1979 bill was endorsed by the Committee on Natural Resources and Agriculture. At the Committee's request, the MSPCA was asked to redraft the bill into appropriate legislative form. During the redrafting process, several bill options were considered. First, the 1894 law could be amended; second, a section could be added to the chapter containing the 1894 law; or third, the 1894 law and the concerns of the science fair bill could both be rewritten and incorporated, addressing both the shortcomings of the 1894 law and the concerns of the science fair bill. The third course was approved by the Committee and a bill resembling the California statute was reported out of the Committee favorably. Representative Richard Dwinell (House Chairman of the Committee on Natural Resources and Agriculture), at the suggestion of the House Counsel, offered on the House floor a stronger substitute bill. Unlike most bills, the entire text of this bill appeared in the House Journal. The bill proceeded easily through the House and Senate. On July 23, 1979, Governor Edward J. King signed the bill into law. It became effective on October 23, 1979. Specifically, the new law incorporates the following points:

1. It repeals the 1894 law, which appeared in the educational statutes, and places the new law in the anti-cruelty statutes.
2. It prohibits in public schools any treatment, experiment and/or procedure which evokes distress and/or interferes with the normal health and well-being of any live vertebrate animals. For example, pithing of frogs and diets deficient in essential foods are not permitted.
3. School principals, administrators, and teachers are liable for ensuring the law is upheld, not only in the classroom, but also in school-related activities such as science fair projects and independent studies.
4. Animals to be dissected must be acquired dead.
5. Classroom pets and other live animals must be humanely treated and safely housed. Adequate care must be provided at all times, including weekends, holidays, and vacations.
6. The fine for violating the law is up to \$100.

The new law proved controversial. Some individuals claimed the bill had been pushed through the legislature "behind everyone's back." The facts are that the bill was given a public hearing, a common practice—not a legal requirement—utilized by legislative committees. The date of the hearing was known and filed with the appropriate authorities months in advance. The legislative agents for the educational community failed to make themselves aware of the bill's progress despite the fact that the intent was clearly stated in the title, "An Act Regulating The Use Of Live Vertebrates For Experimental Or Exhibitional Purposes In Certain Schools." Furthermore, the title was published for numerous weeks in both the House and Senate calendars.

To aid teachers in interpreting the law and designing activities within its parameters, the MSPCA is providing free, upon request, informational packets design-

ed for both elementary and secondary teachers. The Massachusetts Association of Science Supervisors has suggested to its members that "the guidelines set forth by the National Science Teachers Association be used in schools in the state." These guidelines are included in the MSPCA informational packets.

In the coming months and years, the MSPCA looks forward to working closely with professional organizations such as the Massachusetts Association of Science Supervisors and the Massachusetts Teachers Association. Such activities might include interpreting the law on questionable experiments involving live animals and coordinating seminars for teachers on the proper care and handling of live animals.

Massachusetts should be proud that it has taken steps to ensure the dignity of animals and to instill in young people the idea that animals should be treated humanely and respectfully at all times, even in the pursuit of scientific knowledge.

Discussion Paper

State Laws Restricting Animal Experiments in Secondary Schools

Margaret Morrison

Statutory proscriptions concerning the use of live animals in elementary and secondary schools in the United States are significantly less restrictive and comprehensive than the laws, regulations and guidelines pertaining to the professional biomedical research community. This can be attributed to the fact that the federal Animal Welfare Act does not apply to elementary and secondary schools which were expressly exempted in the 1970 Animal Welfare Act Amendments. Therefore, these institutions are not subject to inspection by the U.S. Department of Agriculture, nor are they required to adhere to the standards and guidelines, promulgated under the Animal Welfare Act, covering the humane care, handling and treatment of the animals regulated by the Act. For example, all regulated research facilities are directed to medicate experimental animals to minimize pain and to file reports certifying their compliance with this standard. No similar assurances need be provided regarding experimentation in the elementary or secondary classroom setting.

The use of animals in elementary or secondary schools is also not subject to the rigorous criteria, established by the National Institutes of Health (NIH) Principles on the use of live animals, that apply to recipients of HEW grants and contracts. It is difficult to understand why established biomedical researchers should be subject to more stringent controls than high school students.

Several years ago, legislation was introduced into the U.S. Congress to prohibit the use of animals in painful experiments in primary and secondary schools. However, no action was taken on this legislation, and the bill has not been reintroduced in subsequent Congresses.

It has been on the state level that legislation regarding the use of animals in elementary and secondary schools has been considered and passed. Although it can be argued that the potential exists for the use of state anti-cruelty statutes to stop any cruel experiment in a school, these laws are generally not applied in this fashion. Several states have actually exempted any research or experimentation from their anti-cruelty laws, while in other states, the statutes have never been interpreted to cover such abuse of animals incidental to research procedures or experiments. For this reason, the following states have enacted laws restricting, to varying degrees, experimentation in the schools.

California

In 1973, the California state legislature passed the following law which is considered to be the most effective bill prohibiting precollege experimentation on vertebrates. Several years prior to this, California licensed high schools conducting animal experimentation under its animal care law.

Article 2. Humane Treatment of Animals

1040. In the public elementary and high schools or in public elementary and high school-sponsored activities and classes held elsewhere than on school premises, live vertebrate animals shall not, as part of a scientific experiment or any purpose whatever:

(a) Be experimentally medicated or drugged in a manner to cause painful reactions or induce painful or lethal pathological conditions.

(b) Be injured through any other treatments, including, but not limited to, anesthetization or electric shock.

Live animals on the premises of a public elementary or high school shall be housed and cared for in a humane and safe manner.

The provisions of this section are not intended to prohibit or constrain vocational instruction in the normal practices of animal husbandry. 1973 Cal. Stats. Ch. 76.

Connecticut

In February, 1968, the Connecticut State Board of Education adopted the following policy:

1. Animals should always be maintained under the best possible conditions of health, comfort and well-being.

2. No vertebrate animal should be subjected to any experiment or procedure which interferes with its normal health or causes it pain or distress.

3. Any experiment which involves the use of vertebrate animals should be carried out by or under the personal direction of a person trained and experienced in approved techniques for such experiments.

Although this avowed policy may provide a useful guideline, it is by no means an absolute bar to inappropriate experimentation in the schools.

Illinois

Experiments Upon Animals (1961 Statute)

No experiment upon any living animal for the purpose of demonstration in any study shall be made in any public school. No animal provided by, or killed in the presence of any pupil of a public school shall be used for dissection in such school, and in no case shall dogs or cats be killed for such purposes. Dissection of dead animals, or parts thereof, shall be confined to the classroom and shall not be practiced in the presence of any pupil not engaged in the study to be illustrated thereby. 1961 Ill. Laws, § 27-14.

The 1961 statute has recently been subject to legislative challenge. This is referred to at length by Dr. Wayne Moyer in his discussion paper. It should be noted that, up to the occurrence which led to the proposed amendment, the Illinois law was one of the more obscure laws dealing with animal experimentation in the schools.

The proposed attempt to modify the existing statute by tying it into state anti-cruelty and animal welfare laws would be ineffective as neither of these laws has any real applicability to animal experimentation. The laws would not serve to classify acceptable and nonacceptable uses of animals and the result of the proposed changes could virtually eliminate any restriction on painful experimentation in Illinois schools.

Maine

Maine enacted the following law in 1975:

Vivisection Prohibited in Public and Private Schools

1. Use of animals in elementary schools. No school principal or headmaster shall allow any live vertebrate to be used in grades kindergarten through 8 of any public or private school as part of a scientific experiment or for any other purpose in which said vertebrates are experimentally medicated or drugged in a manner to cause painful reactions or to induce painful or lethal pathological conditions. No live vertebrate shall be used as part of a scientific experiment or for any other purpose in grades kindergarten through 8 in which said vertebrates are injured through any other type of treatment, including but not limited to anesthetization or electric shock. These provisions shall also apply to any activity associated with or sponsored by the school system.

2. Use of animals in secondary schools. No school principal or headmaster shall allow any live mammal, bird or chelonian, excepting bird eggs, to be used in any scientific experiment or for any other purpose in grades 9 through 12 in which said mammals, birds or chelonians are subjected to treatment and conditions prohibited in subsection 1. These provisions shall also apply to any activity associated with or sponsored by the school system.

3. Treatment of animals in general in grades kindergarten through 12. Live animals used as class pets or for purposes not prohibited in subsections 1 and 2 in grades kindergarten through 12 shall be housed or cared for in a safe and humane manner. Said animals shall not remain in school over periods when such schools are not in session, unless adequate care is provided at all times.

4. Standards of treatment. Any animal, whose use is permitted under this section, shall be treated in accordance with a set of ethical and humane standards to be promulgated by the Commissioner of Agriculture, Division of Animal Welfare, after the consultation with representative groups in the State having an interest or expertise in the field of animal welfare, biology and education.

5. Enforcement. Enforcement shall be the responsibility of the Commissioner of Agriculture in consultation with the Commissioner of Educational and Cultural Services.

6. Penalty for violations. Whoever violates this section shall be punished by a fine of not more than \$75.

7. Exemption. This section shall not apply to vocational agricultural courses, Future Farmers of America, school-sponsored 4-H clubs and similar school activities where improved nutrition and good and proper animal husbandry are the objectives. Maine Rev. Stat. Ann. 7, § 1055.

It is reported that this law is not being enforced and that many teachers are not aware of its existence.

Massachusetts

In 1979, the Governor signed into law a bill to replace Massachusetts' blanket antivivisection statute which was generally ignored. The bill had been sponsored by a high school biology teacher who was concerned that painful and manipulative animal experimentation was widespread in Massachusetts despite the old law banning vivisection in the schools. Following is the text of the amended law.

Section 1. Section thirty-three of chapter seventy-one of the General Laws is hereby repealed.

Section 2. Chapter 272 of the General Laws is hereby amended by inserting after section 80, inserted by chapter 112 of the acts of 1977, the following section:

Section 80. No school principal, administrator or teacher shall allow any live vertebrate to be used in any elementary or high school under state control or supported wholly or partly by public money of the state as part of a scientific experiment or for any other purpose in which said vertebrates are experimentally medicated or drugged in a manner to cause painful reactions or to induce painful or lethal pathological conditions, or in which said vertebrates are injured through any other type of treatment, experiment or procedure including but not limited to anesthetization or electric shock, or where the normal health of said animal is interfered with or where pain or distress is caused.

No person shall, in the presence of a pupil in any elementary or high school under state control or supported wholly or partly by public money of the state, practice vivisection, or exhibit a vivisected animal. Dissection of dead animals or any portions thereof in such schools shall be confined to the classroom and to the presence of pupils engaged in the study to be promoted thereby, and shall in no case be for the purpose of exhibition.

Live animals used as class pets or for purposes not prohibited in paragraphs one and two hereof in such schools shall be housed or cared for in a safe and humane manner. Said animals shall not remain in school over per-

iods when such schools are not in session, unless adequate care is provided at all times.

The provisions of the preceding three paragraphs shall also apply to any activity associated with or sponsored by the school.

Whoever violates the provisions of this section shall be punished by a fine of not more than one hundred dollars. 1979 Mass. Acts Ch. 439.

Pennsylvania

In 1949, the Pennsylvania state legislature passed its Humane Education Statute Article XV SS1514, "No cruel experiment on any living creature shall be permitted in any public school of this Commonwealth." (1949 Pa. Laws Art. XV § 1514.) Unfortunately, there is no evidence to suggest that this law has ever been tested in the courts or that it has any real effect on the types of experiments conducted in Pennsylvania schools.

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Discussion Paper

The Debate Over Animal Rights: An Introduction*

Tom Regan

There is a growing interest in some circles in the idea of animal rights. Not surprisingly, others find the very idea laughable. But laughter is no substitute for informed judgement and the ideas people find most amusing, sometimes turn out to be the very ones that most challenge their slumbering prejudices. The present essay is an attempt to take a few first steps. In Part I, the ideas of moral and legal rights are compared and contrasted. The question of what constitutes a "right" is discussed in order to provide a clearer focus for the rest of the paper. In Parts II and III, arguments for and against ascribing to animals moral and legal rights are examined. Part IV sketches some implications and poses some questions for further thought.

I. Moral Rights and Legal Rights

A *right* can be understood as a valid claim the possessor has against another. For example, if I have a right to an inheritance, then I can not only claim that the inheritance is mine (that is, not only am I empowered to say that is mine)—I am justified in taking certain steps to see that I actually get it (that is, my claim is valid). By contrast, someone who does not have a right to an inheritance may claim it is his but, lacking any right to it, he is not justified in taking steps to get it. The criteria establishing the validity of anyone's claim varies depending on whether one is speaking of moral rights or legal rights. Legal rights acquire their validity from the law while moral rights acquire their validity from the principles of an enlightened morality. Both ideas need to be explained more fully, beginning with the idea of legal rights.

It is clear that the laws of one country frequently differ from the laws of another. This variability occurs because laws are created by the legislative acts or decrees of various persons living in various countries at various times and, like other creative activities, the products of this one are bound to differ. A similar situation occurs in the case of legal rights of the citizens of various countries. Moreover, because legal rights are made by humans, they can also be unmade. For example, slave owners in the United States once had the legal right, based on property rights, to buy and sell slaves.

The idea of a moral right differs in important respects from that of a legal right.

*A similar version of this paper was presented to the Fourth Conference on Ethics, Humanism, and Medicine at the University of Michigan in November 1979, and is reprinted here with permission of the publisher of the Proceedings, Alan R. Liss, Incorporated, NY.

First, moral rights are supposed to be universal—that is, if any individual (A) has a moral right, then all other individuals like A in the relevant respects also have this right. Second, moral rights, unlike legal rights, are not the result of human creative activity. They are not “brought into existence” by democratic vote or the whim of a despot. Rather, moral rights are discovered, not by doing empirical science, but by thinking hard about moral questions. Like basic postulates in science, moral rights (if there are any) are what reason compels us to include in the most satisfactory theoretical account of morality. Thus, legal rights are created by humans, moral rights are not.

A final defining characteristic of moral rights is that they are equal. This means that if any two individuals, A & B, both have the same moral right, then both possess this right equally. No one person's moral right can be greater than any other's. Thus, for example, whites do not have greater moral rights than blacks, men than women, adults than children, or Americans than Viet Cong.

Not everyone has agreed that there are moral rights. The arguments for and against them are too complex and varied to receive a complete airing here. However, one attempt to dispense with moral rights needs to be characterized, both because it is a widely held and influential view and because its apparent shortcomings highlight the importance of moral rights. The attempt in question is the position (or positions) known as utilitarianism. Utilitarianism emphasizes the consequences (the results or effects) of actions or rules of action, including legislation, maintaining that the morality of an action or rule depends entirely upon how valuable the consequences are. Moral rights are, according to this theory, superfluous; there is no good reason to postulate them and very good reason not to.

The major difficulty encountered by all forms of utilitarianism is the apparent commitment to the view that the end justifies the means. So long as the results of a certain action or rule bring about the best consequences, the action or rule are above moral criticism, according to the utilitarian. Thus, acts or rules that are flagrantly wrong might emerge as morally quite all right. A standard example is that of slavery. Might it not be the case that an economy based on slavery brought about the best consequences, all considered, in nineteenth century America? If so, then utilitarians seem necessarily to be committed to supporting slavery under those conditions.

The idea of moral rights is useful when attempting to explain why slavery is wrong. Since human beings each have certain moral rights (e.g., to life and liberty), and because these rights are universal and equal, it cannot be morally justifiable to treat some human beings, against their will, in ways that it would be wrong to treat others. Although many of the details and subtleties of this debate have not been discussed, hopefully enough has been said to suggest why the idea of humans having moral rights is an important one.

For the present, let us accept that human beings do have certain moral rights, such as the rights to life, liberty, and the pursuit of happiness. Two further questions can then be explored. First, what are the *grounds* humans possessing moral rights? Second, how do alternative answers to this first question impact on the debate over whether animals have moral rights? These are the issues that are dealt with in Part II.

II. Do Animals Have Moral Rights?

What are the grounds for human possession of moral rights? Various answers have been proposed. A cursory examination of some of the most important follows.

The Species Requirement: This view states that all and only members of the species *Homo sapiens* have moral rights. Thus, all humans have moral rights but all animals lack them.

This requirement can be challenged in a variety of ways, but one stands out. The Species Requirement implies that moral questions can be answered by biological considerations—in this case, species membership. However, prejudices such as racism and sexism also attempt to answer moral questions on biological grounds, in their case by appeals to race or sex. If, as is agreed, these latter positions are morally unacceptable, the suspicion arises that the same is true of the view espoused by the Species Requirement. It, too, expresses a morally unacceptable prejudice (what many now call "speciesism")—namely, a prejudice against members of species other than our own. To make this clearer, imagine the following possibility.

Beings from another planet (extraterrestrials) pay Earth a visit. They are intelligent, display the ability to remember and imagine, feel pleasure and pain, are able to communicate, have preferences and, in a word, are like "normal" humans when it comes to their abilities. However, despite these noteworthy similarities, they do not have moral rights, according to the Species Requirement. But this surely is rank prejudice, comparable in terms of its logic to racism and sexism. The Species Requirement, therefore, is inadequate.

The Rationality Requirement: This view holds that all and only rational beings have moral rights. Thus, even extraterrestrials have moral rights if such beings are rational. Animals, however, since they are not rational, do not have moral rights.

Two objections to this view will suffice. First, many animals appear to be able to reason. Accordingly, if we were to accept the Rationality Requirement, many animals would have moral rights. Second, there are many human beings who are not rational, such as severely mentally enfeebled humans and the mentally deranged. However, if all humans have moral rights, these humans have moral rights. And if they have moral rights and yet are not able to reason, then the ability to reason cannot be a requirement individuals must meet in order to have moral rights.

The Modified Species Requirement: This requirement states that all and only those individuals who belong to a species whose members typically (or normally) are rational have moral rights. Thus this requirement does not include only *Homo sapiens*; even extraterrestrials can have moral rights, if the typical members of their species are rational. The Modified Requirement does allow that the enfeebled and deranged have moral rights since they belong to a species (*Homo sapiens*) whose members are normally or typically rational. Thus, this requirement overcomes the principal objection raised against the Rationality Requirement. Animals, however, come out on the short end again, since they do not belong to species whose members normally or typically are rational.

The apparent success of this requirement is just that—apparent. First, if it is true that some animal species do normally or typically have members that are rational, then all members of these species will have moral rights, given the Modified Require-

ment. Thus, all members of certain species of primates would seem to qualify as possessors of moral rights. Second, the case of our extraterrestrials needs to be reconsidered. We have supposed that the ones who visit the earth are rational, but now imagine that they are abnormal ones, so far as their species is concerned. That is, the members of their species normally or typically are *not* rational. This being so, we would be compelled to deny that our visitors had moral rights according to the Modified Species Requirement. This is not because of any fault of their own nor because they are unable to do something normal humans are able to do, but merely because of some fact about the species to which they happen to belong. This is palpably unfair. Whatever else may be unclear or uncertain about moral rights, it at least is clear and certain that no one individual can lack moral rights because of what is true of some *other* individual(s).

A general theme emerges from the inadequacy of the preceding requirements. It is that moral rights, because they are possessed by individuals, must be based on what is true of the individuals who possess them *and* that the requirement for possessing moral rights must not exclude those humans who are enfeebled or deranged. This is why many have thought that the next requirement is the most adequate.

The Sentience Requirement: All and only individuals who are sentient (defined as the ability to experience pleasure and pain) have moral rights. Thus, deranged and enfeebled humans have moral rights. And so, too, do members countless species of animals.

Not everything is smooth sailing even for this requirement. In particular, the moral status of irreversibly comatose human beings poses a serious problem since, given the Sentience Requirement, these humans have no moral rights. However, this does not mean that we would be morally entitled to do anything we like to these humans. On the contrary, it is open to anyone who accepts the Sentience Requirement to insist that all humans must be treated with respect, even those who are irreversibly comatose, because (a) we may not *know* that they are in an irreversible state and because (b) we ought always to act in ways that promote respect for human life.

Now, *if* the Sentience Requirement is considered adequate, a rational basis is provided for enfranchising many animals in the class of individuals possessing moral rights. For there are many animals who are sentient. Granted, there are uncertainties over where we draw the line between those who can feel pain and those who cannot. But there can be no reasonable doubt that many of the animals routinely used by humans as a source of food, in research, in science fairs and in classroom demonstrations would qualify as possessors of moral rights on the grounds of being sentient.

From the moral point of view, therefore, we must seriously inquire into the justifiability of using animals in these ways since overriding moral rights cannot be justified on the grounds of mere utility. This is true in a human case, such as that of slavery, or in the case of our use of animals in research or science fairs. Perhaps someone will suggest that the case of animals is different, that our use of them can be justified because of its utility, whereas our use of other humans cannot. Doubtless, many people believe this. The challenge these people must meet is to give good reasons for thinking this true. This challenge is compounded all the more by the fact that the animals in question resemble enfeebled human beings in the relevant respects—namely, both are sentient. The importance of the idea of animal rights is due, in part, to its role in forcing us to come to terms with the morality of the ways we

routinely treat animals. It is also important because it is relevant to the related issue of granting legal rights to animals, an issue to which we shall now turn.

III. Should Animals Have Legal Rights?

Though many people apparently think otherwise, animals do not now have legal rights. True, they are protected by various laws, such as anti-cruelty legislation and the Endangered Species Act. But buildings and works of art also protected by laws, yet they do not have legal rights. Indeed, so far as the law is currently written and understood, animals are in the same general legal category as buildings and works of art. Like them, animals are not "legal persons." Since only legal persons can possess legal rights, animals do not possess legal rights.

Even granting that animals are not now accorded the status of legal persons, it does not follow that they cannot or should not be given this status in the future. To begin with, "persons" within the law are not restricted to human beings. Ships and corporations, for example, are legal persons. Thus, in arguing that animals ought to be accorded the status of legal persons, one is not asking the law to perform the biological trick of changing animals into human beings! Moreover, if we ask what characterizes legal persons, a strong case can be made for placing animals in this category and removing them from the legal limbo they presently share with buildings and works of art. The following ideas characteristically are attributed to legal persons:

- Legal persons can be injured;
- Legal persons can be benefitted;
- Legal persons have interests.

Now whereas there is no literal sense in which, say, a building can be injured, benefitted, or have its interests represented, respected or ignored, the same is not true in the case of those animals who are sentient. For these animals do have an interest in avoiding pain; they can be injured; and they are benefitted when, for example, they are permitted to live in an environment attuned to their nature. There is, then, no logical bar to granting the status of legal person to these animals.

In reply it might be argued that since legal rights are valid claims, and since animals cannot claim anything, they cannot have legal rights. This objection does not stand up to scrutiny. Ships cannot claim anything, yet these "individuals" have legal rights. Animals, therefore, cannot be denied legal personhood because of their inability to make claims. Furthermore, enfeebled humans often are unable to make claims, and yet the law recognizes that others, acting on behalf of the interests of the enfeebled, can claim what is due them as matter of legal right. This being so, there is no compelling reason for denying that others, acting on the behalf of the interests of animals, could make and press those claims which the animals themselves are incapable of making, pressing or, again like the enfeebled, even understanding.

However, even if animals *could* be accorded the status of legal persons and *could* be accorded legal rights, the question remains—ought we to do so? This question would be of only theoretical interest if we had good reason to believe that present and forthcoming legislation *already* respects and protects the interests of animals. If it did, then making animals legal persons and giving them legal rights would be superfluous. But the law does not necessarily respect and protect the interests of animals. For example, witness this not untypical ruling of the New Mexico Supreme

Court on the legality of cock-fighting.

While it is true that in the minds of some men, there is nothing more violent, wanton, and cruel, necessarily producing pain and suffering to an animal, than placing a cock in a ring with another cock, both equipped with artificial spurs, to fight to the death, solely for man's amusement and sport, others consider it an honorable sport mellowed in the crucible of time so as to become an established tradition not unlike calf-roping, steer riding, bulldogging, and bronco busting.

What this ruling illustrates so well is that the law allows human interest to be the measure of the legality of practices involving animals, *independently of how these practices affect the interests of the animals themselves*. The court in this case weighs the interests some humans have in avoiding cruelty against the interests other humans have in preserving one among a number of sports "mellowed in the crucible of time." Nowhere is there any mention of whether cock-fighting is in the interests of the chickens, nor will there be such consideration, so long as animals are denied the status of legal persons.

How, then, might we argue on behalf of animals in this regard? The following argument merits consideration.

1. The law already allows that nonhumans can be legal persons; therefore, there is no reason why animals cannot have this legal status.
2. The law already accords legal rights to mentally enfeebled humans.
3. Sentient animals are similar to enfeebled humans both in terms of their sentience and because the case for postulating moral rights in the case of these humans is just as strong as the case for postulating them in the case of these animals (see Part II, above).
4. The law ought to treat similar cases similar.
5. Therefore, the law ought to treat animals similarly to the way it treats enfeebled humans.
6. Therefore, the law ought to accord legal rights to sentient animals.

Whether this argument can withstand the test of informed criticism cannot be argued here, but it does serve to illustrate how one might argue for granting legal rights to animals independently of appeals to sentient or "cuddly" qualities. The issue is one of fact and reason, not of "mere sentient."

IV. Some Questions

In the present case, as in all other controversial, important ones, questions are easier to come by than answers. Especially in the area of the law, questions abound, and a collective wisdom at least equal to that of Solomon's may be necessary to make intelligent headway, if animals are accorded legal rights. The central question is—what form should future animal legislation take? For example, should the law make it possible for animals to sue for damages? If so, what if the aggrieved animals happens to die or happens to have been killed—then who is the rightful heir? Indeed, does it make any sense at all even to think of one animal as "the heir" of another? Would not the law become absurdly disorderly if animals were permitted legal rights?

Not necessarily. For there is another legal approach than that of making animals the beneficiaries of legal proceedings brought on their behalf. This is to punish those who violate their rights. In fact, of course, this is similar to the approach of present anti-cruelty legislation, so that any future legislation based on the legal rights of animals could be an extension of this.

Given this approach, what ways of treating animals ought to be made illegal? Certainly more than presently existing anti-cruelty legislation is required. For this legislation almost invariably makes it legally punishable to treat animals in certain ways only on the condition that the accused was "wanton" or "intentionally cruel" in his treatment of the animal in question. This is altogether inadequate as a means of legally protecting animals, mainly because it requires proving that the accused did what he did from a particular mental state—e.g., that he was intentionally cruel—and the existence of mental states is extremely difficult to establish. If, instead of putting laws in terms of human cruelty, they were put in terms of animal rights, the situation would be different. For then persons could be convicted for violations of animal rights, independently of whether they happened to be cruel, wanton, etc. It would be enough that they acted in ways that violated the animal's rights.

If the interests of the animals themselves, and not just human interests in animals, are taken into account, how might we rationally resolve those cases where the interests of animals and humans come into conflict? Who could reasonably qualify as a spokesperson of the interests of animals and represent their interests with knowledge and authority? What would be the impact of granting animals legal rights on our standard practices of using them in research, in the classroom, in science fairs, sport and the many other ways present custom condones? In particular, would the legal rights of animals serve as a legal check of the human right of freedom of inquiry, making it either legally impossible or at least legally extremely difficult to use animals in laboratory experimentation and how would this effect the quality of research? The issue of enfranchising animals, not just by having laws that "protect" them, but drafting and enforcing ones that are grounded in their interests, clearly is fraught with enormously difficult and important practical implications that in many ways go to the heart of our traditional beliefs and institutions. As remarked earlier, the questions come more readily than the answers. And yet, as was observed at the outset, the issues really are ones that call for informed judgment and rational inquiry.

Suggestions for Further Reading

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- Singer, P. (1976) *Animal Liberation*. Random House, N.Y.
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SUMMARY

The Conference on the Use of Animals in High School Biology Classes and Science Fairs signaled the first time scientists, teachers and representatives of educational and animal welfare organizations from the United States, Europe and Canada convened to discuss the ethical considerations and scientific validity of student projects involving pain or stress to vertebrates.

The papers published in this proceedings provided the basic format for the three areas designated: educational objectives and animal experimentation review; the use of vertebrates in biology courses; and high school science fairs: evaluation of live animal experimentation. The discussion session which emerged from the formal presentations was devoted to the points of contentions and areas of agreement among the participants. The general consensus was that,

(1) Observational studies of live animals should be encouraged in the classroom, as well as in wild and semi-wild settings such as zoos and farms, in order to stimulate not only the study of biology but also natural history and wildlife conservation.

(2) Pre-service and in-service programs need to be developed to train teachers in the use and handling of animals for the classroom, as such training is not adequately provided.

(3) Emphasis be placed on the need to "clean up" educational materials (e.g., texts, films, workbooks) which promote a mechanistic, interventive approach toward animal studies.

The majority of the discussion session was devoted to the relative disagreements over appropriate activities for high school science fairs. Spokespersons for the best known and largest of the fairs in the United States, The International Science and Engineering Fair (ISEF) argued that: Students who wish to enter science fairs are generally highly motivated, and therefore should be given the opportunity to use their skills and intelligence in a scientific endeavor while being guided in an instructive yet not overly restrictive manner.

Representatives of other organizations, including animal welfare, countered with arguments that high school students are in a formative stage of their educational careers and are attempting to master the fundamentals of biology. Considering the lack of educational and professional experience, studies which involve the infliction of pain or inducement of physical or mental stress on sentient animals are not warranted. In addition, students may develop an erroneous impression that technical knowledge is synonymous with scientific research. (See T. Grafton, and F.B. Orlans for background information.)

It was suggested by Dr. Michael Fox, co-chairman of the Conference, that if a total ban on experimentation which involves a significant intervention with the animal or its environment, such as surgery, administration of toxic substances and nutritionally deficient diets, was unacceptable to the ISEF, then the students who wish to perform such experiments should be restricted to participation in projects which are conducted only

in a bona fide research facility, under the direct supervision of a qualified biomedical scientist. This met with general approval, but Dr. Thurman Grafton, Chairman of the Scientific Review Committee of the ISEF, brought up the point that students living in areas with few universities or biomedical labs would be at a distinct disadvantage.

Dr. Fox responded by drawing attention to the agricultural research stations throughout the country which provide equal if not more opportunities for student research projects. Dr. Grafton and Mr. E.G. Sherburne, Director of Science Service (the sponsoring organization of the ISEF) conceded this point to Dr. Fox and agreed to make ISEF rule changes along these lines for the 1981 competition. These changes will bring the major science fairs in the United States more into line with the conduct of the Canadian science fairs (see H.C. Rowsell) and eliminate what many people believe to be the critical fault in the present ISEF rules, namely, that they allow highly sophisticated procedures to be performed in situations which cannot provide the conditions necessary to safeguard both the student and the animals. This proposed rule change is a step forward in curtailing inappropriate experiments by unqualified individuals.

APPENDICES

The following material is provided by The Humane Society of the United States and is included for educational reference.

Guidelines for Study of Animals in Elementary and Secondary Schools

The Humane Society of the United States believes that the study of animals in elementary and secondary school curriculum should foster in students a humane concern for life, as well as provide a learning experience. In these days of frequent actions of man against man, and man against animals, lessons which teach moral values should be of prime importance in the education of young people. Promotion of such concepts can be achieved by the study of biology, conservation and natural history.

Animal experimentation performed by primary and secondary school students, that interfere with the normal health of an animal, causing pain, suffering, anxiety or stress, are clearly incompatible with the principles of the humane ethic. The HSUS finds that a significant incidence of live animal experimentation occurring in schools today does not conform to the principle of not inflicting pain. Key to this policy is the restriction that no living vertebrate may be used in a manipulative or interventive experiment. Moreover, many animals kept in schools lack adequate care. The following guidelines are established to amplify this policy in practical terms for use in elementary and secondary schools.

I. Selection of Live Species

- A. Less complex organisms (bacteria, fungi, protozoa, worms, snails or insects) are preferred because of wide variety, availability in large numbers and relative simplicity of maintenance.
- B. Pathogenic organisms (those causing disease in man) are unsuitable under any condition.
- C. Vertebrate experiments are restricted to observational, non-interventive studies.

II. Prohibited Procedures and Experiments

No live vertebrate experiment should be performed by any student or in the presence of any student, if the experiment interferes with the normal health of the animal, or causes pain, suffering, anxiety or distress. This includes but is not limited to:

- A. Surgery (with or without anesthesia).
- B. Nutritionally deficient diets or withholding food and/or water.
- C. Administration of drugs or medications for experimental purposes.
- D. Use of ionizing radiation.
- E. Intentional exposure to carcinogens, other hazardous substances, pollutants, extremes of temperature, excessive noise or noxious fumes.
- F. Negative reinforcement techniques or other distressing stimuli.

III. Acceptable Studies

Acceptable live vertebrate studies include:

- A. Observations of normal living patterns of wild animals in the free living state or in zoological parks, gardens, or aquaria.

B. Observations of normal living patterns of pets, fish or domestic animals.

Chicken embryos (eggs collected in the wild are not acceptable) may be used in observational studies only. If normal egg embryos are to be hatched, satisfactory arrangements must be made for the humane disposal of chicks. If such arrangements cannot be made, then the chicken embryos must be destroyed on the 19th day of incubation.

IV. Dissection

Any student who objects to dissection should not be forced to perform or witness such a procedure, but should be given alternative projects. No living vertebrate to be dissected should be killed in the presence of a student. Students should not be instructed to obtain and kill vertebrates for dissection. Teachers or course supervisors should take reasonable steps to ensure that specimens are, or have been, killed humanely, and that the use of specimens do not jeopardize the stability of a species' population.

V. Animal Care

Any live animal study, except the observation of animal(s) in the natural habitat or usual surroundings, should be conducted in locations where proper supervision and adequate animal care are provided. The long-term housing of vertebrates in classrooms is *not* recommended. When animals are maintained in classrooms, housing and care should meet professional standards for animal care. The following should be considered in a program for animal maintenance:

- A. Cages and enclosures should have sufficient space for normal postural, social and behavioral adjustments and should be regularly cleaned.
- B. Incompatible species or animals should not be housed together.
- C. Food and water available to the animals should be consistent with dietary and metabolic needs, and the containers regularly cleaned.
- D. Bedding material should be provided, as well as shelves, scratching posts, etc., when appropriate.
- E. Temperature, lighting (including sunlight) and other environmental factors should be regulated within the range for the species.
- F. Precautions should be taken to prevent harassment of animals, and injury to both students and animals should be taken.
- G. Live animals should not remain in schools over periods when the school is not in session unless the level of care can be maintained.
- H. Sick animals should receive veterinary treatment.
- I. Prior arrangements should be made for placement of classroom animals when study or school term is completed.
- J. In rare instances when euthanasia is necessary, it shall be performed in a (rapid and painless) manner by an adult experienced in these techniques. Warm blooded vertebrates should be taken to a veterinarian or animal shelter for this purpose.

It is essential that all involved comply with applicable federal, state and local laws governing animal procurement and usage.

VI. Supervision

- A. Qualified teachers should directly supervise students, give prior approval to any plan to use live animals, oversee all student work, and inspect the

- animal at least once daily.
- B. Students should have the necessary knowledge, expertise and maturity to conduct and understand the work contemplated.
- C. Teachers should have the benefit of course work in animal care either through pre-service or in-service training.

Students preparing projects for science fairs should refer to *Code of Practice for Animal Related Projects in Science Fairs* prepared and distributed by The Humane Society of the United States, 2100 L Street, N.W., Washington, D.C. 20037.

Bibliography

- Animal Welfare Institute, *Humane Biology Projects*, Washington, D.C.
Institute for the Study of Animal Problems, *Animals in Education, The Use of Animals in High School Biology Classes and Science Fairs*, Washington, D.C., Summer, 1980.
Orlans, Barbara, *Animal Care from Protozoa to Small Mammals*, Addison and Wesley, Menlo Park, California, 1977.

Additional information can be obtained from The Humane Society of the United States, 2100 L Street, N.W., Washington, D.C. 20037 and Canadian Council on Animal Care, 1105-151 Slater, Ottawa, Canada K1P 5H3.

The Humane Society of the United States, 2100 L Street, N.W., Washington, D.C. 20037

Code of Practice for Animal Related Studies in Science Fairs

It is the policy of The Humane Society of the United States that elementary and secondary school studies of animals should foster a humane regard for the animal kingdom and a respect for life. The Society believes all live vertebrate animal experiments (other than those for the purpose of behavioral observations and ecological studies that involve no direct manipulations) should be prohibited in elementary and secondary schools and related activities. Learning experiences that entail animal suffering are not justified and are unlikely to add positively to a student's character development.

Choice of Subject

The use of phylogenetically less complex organisms such as plants, bacteria, fungi, protozoa, worms, snails or insects should be encouraged as much biological information can be revealed through such studies. Such organisms are readily available in large number and wide variety, they are usually simple to keep, and disposal is relatively easy.

Non-manipulative procedures may involve vertebrate animals, i.e., mammals, birds, reptiles or fish.

Acceptable Types of Study

No experiments or procedures may be performed on any vertebrate animal that might cause physiological or psychological reactions indicating pain, suffering, anxiety, stress or any interference with its normal health. Vertebrate experiments may only involve:

- Observations of normal living patterns of wild animals in the free living state or in zoological parks, gardens or aquaria.
- Observations of normal living patterns of pets, fish or domestic animals.

Chicken embryos (eggs collected in the wild are not acceptable) may be used in observational studies only. If normal egg embryos are to be hatched, satisfactory arrangements must be made for the humane disposal of chicks. If such arrangements cannot be made, then the chicken embryos must be destroyed on the nineteenth day of incubation. No eggs capable of hatching may be exhibited in science fairs.

Cells such as red blood cells, other tissue cells, plasma or serum purchased or acquired from biological supply houses or research facilities may be used in science fair projects.

No living vertebrate animal shall be displayed in exhibits in science fairs.

Supervision

All experiments must be directly supervised by a qualified science teacher or scientist who shall approve the student's protocol before the study is initiated. Students must have the necessary comprehension and abilities for the work contemplated. The supervisor shall oversee all experimental procedures, shall be responsible for their non-hazardous nature and shall personally inspect experimental animals during the course of the study to ensure that their health and comfort are fully sustained.

Care

If vertebrate animals are to be used, the housing, feeding and maintenance of all subjects should at the minimum accord with the standards of animal care as outlined in The HSUS Guidelines for the Study of Live Animals in Elementary and Secondary Schools. Clean drinking water shall be available at all times and a palatable and balanced diet shall be provided in sufficient quantity for normal growth and maintenance.

Note: Educators and students may obtain a free listing of recommended study projects and/or project book for pre-university levels by writing to one of the following sources:

Animal Welfare Institute
P.O. Box 3650
Washington, DC 20007

The Humane Society
of the United States
2100 L Street, NW
Washington, DC 20037

Canadian Council on Animal Care
1105-151 Slater
Ottawa, Ontario
CANADA K1P 5H3

The Humane Society of the United States, 2100 L Street, N.W., Washington, D.C. 20037

Model Bill on the Study of Animals in Elementary and Secondary Schools and in Science Fairs

Introduction

Elementary and secondary school study of live animals should foster a humane regard for living creatures. The Humane Society of the United States finds animal experimentation that interferes with normal health or causes pain, suffering, anxiety or stress to be incompatible with this principle.

The HSUS has determined that a significant incidence of animal abuse is occurring in the schools today. Attempts to achieve voluntary reform have proven unsuccessful, and legal remedies are therefore necessary. Existing state anti-cruelty laws are generally considered inapplicable since the use of animals for all forms of research is expressly exempted from the cruelty statutes in several states, and in other states, the general statutes have not been interpreted by the courts to cover cruelty incidental to research.

The HSUS suggested model law is based on California and Massachusetts laws. It is designed to cover both classroom work and extracurricular activities such as science fairs.

It is recommended that this law be an amendment to the anti-cruelty statute, although placing it within the education statute remains another option.

AN ACT TO PREVENT CRUELTY TO ANIMALS IN ELEMENTARY AND SECONDARY SCHOOL SCIENCE CLASSES AND SCIENCE FAIRS.

Section 1

- a) The term "animal" means any member of the kingdom Animalia.
- b) The term "vertebrate animal" means any animal belonging to the subphylum Vertebrata of the phylum Chordata, and specifically includes all mammals, fishes, birds, reptiles and amphibians.

Section 2

No school principal, administrator or teacher shall allow any live vertebrate animal to be used in any elementary or secondary school, or in any activity associated with such school, such as science fairs, as part of a scientific experiment or procedure in which the normal health of the animal is interfered with, or in which fear, pain, suffering, or distress is caused. Such experiments and procedures include but are not limited to surgery, anesthetization, and the inducement by any means of painful, lethal, stressful, or pathological conditions through techniques that include but are not limited to:

- a) administration of drugs;
- b) exposure to pathogens, ionizing radiation, carcinogens, or to toxic, hazardous, or polluting substances;
- c) deprivation, and

d) electric shock or other-distressing stimuli.

Section 3

No person shall, in the presence of a pupil in any elementary or secondary school, perform any of the procedures or experiments described in Section 2 or exhibit any vertebrate animal that has been used in such manner. Dissection of any dead animal, or portions thereof, shall be confined to the classroom and to the presence of students engaged in the study to be promoted thereby.

Section 4

Science fair projects originating in other states that do not conform with the provisions of Section 2 shall not be exhibited within the State.

Section 5

Any live animal kept in any elementary or secondary school shall be housed and cared for in a humane and safe manner and shall be the personal responsibility of the teacher or other adult supervisor of the project or study.

Section 6

Any person convicted of violating this Act or any regulation promulgated under any provision of this Act shall be punished by imprisonment for not more than _____ months or fined not more than _____ dollars (\$_____) or both.* Every violation of this Act shall be considered a separate offense.

*The penalty should be the maximum for a misdemeanor for the state in question.

Note: *Guidelines for the Study of Live Animals in Elementary and Secondary Education and Code of Practice for Animal Related Projects in Science Fairs* are available from HSUS for use in schools and science fair competition.

The Humane Society of the United States, 2100 L Street, N.W., Washington, D.C. 20037